An Evaluation of Environmental Impact Assessment within the Planning Process in Libya and the UK in relation to Cement Manufacture

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Re. Salah Elbah 2002

Abstract

This thesis presents both the ancient and recent history of the uses of limestone, including an outline of the history of limestone excavation. An evaluation of the environmental impact of cement manufacture upon the landscape, the green cover, the wildlife and the people is presented. Remedies and solutions are given to reduce the harm-ful effects resulting from the severe exploitation of limestone and the consequence uses of it.

In the introduction to the thesis, the aims of the research, the objectives of the research and the rationale are clearly set out to indicate the form of the study. The methodology applied to the research is described and lays down the lines along which the investigations are followed throughout the thesis.

To put the research into context the history of the ancient civilisations of Libya, their ways of living, their architecture and their constructions using limestone are described to demonstrate that there is great significance in their techniques. The primitive techniques they used to excavate and extract the limestone for their domestic buildings is noted in relation to the topography and the prevailing climate in Libya. The latter has a major impact, not only upon the forest and other forms of vegetation but also upon the native peoples of north-east Libya.

The history of mining in Libya, especially of the cement industry is presented with outlines of geologic and stratigraphic distribution of Libyan limestone and clay raw materials. The Libyan and the UK planning procedures are also narrated to illustrate the controls by governments over mineral exploitation including copies of the required official Libyan and the UK contracts *pro formae.*

The environmental impact assessment process is discussed, including several definitions and a short historical review. This is presented to illustrate the global significance of environmental management in response to degradation due to resource exploitation and its knock-on effect in different parts of the world. An overview of policies supporting the concept of sustainable development is given.

The procedures relatede to quarry restoration such as site analysis and evaluation, landform considerations, soil preparation, plant species selection, methods of vegetation establishment and management and the after-use of restored land are discussed. The use of the technique of restoration blasting is debated and its potential for restoration of former quarry faces is presented. Furthermore, the potential for the incorporation of ancient Libyan traditions, and the application of Roman and Greek ideas to quarry restoration in modern quarry sites forms the basis of the proposal at Derna. Such ideas can be effectively applied with similar methodologies to create simulations of those old ideas at any future quarry site.

Environmental concerns are noted and presented in terms of the need for clearer management strategies. This is highlighted through the discussion of the definitions of ISO 14001 & BS 7750 as a means of developing appropriate international standards in managing large quarry and cement manufacturing operations.

Two case studies, in the two countries Libya and the UK, are carefully examined to compare and contrast the different approaches operating in each area with regard to the manufacture of cement but more significantly with the processes adopted for the restoration of the limestone and clay quarries. This includes, in the case of the UK example a synopsis of environmental works introduced by the leading landscape architect, Sir Geoffrey Jellicoe 1943.

The research highlights similarities and differences in the histories and processes of these industries in the two countries. In particular, the transferability of key environmental and planning procedures and process are considered. The incorporation of novel approaches to restoration work in Libya is discussed.

Chapter 1. Introduction

1.1. Introduction and Literature Review

The study aims to evaluate the process of environmental impact assessment in two contrasting countries - namely Libya and the UK. It considers this by means of a comparison of the limestone quarrying and cement manufacturing industries. It also considers the potential for site after-use, for either recreation/amenity or conservation.

This research has been achieved by following the information and methods provided by previous experts involved in the subject. This has therefore, paved and facilitated the way of the current research.

Key literature sources, web sites (*which are relevant to the project's aim in both languages, Arabic and English*) are more fully considered and reviewed in the relevant main chapter. This initial review considers and introduces some of the key sources. These influenced the subsequent programme of research.

In *The Reclamation of Limestone Quarries Using Landform Replication*, (1997) by Dr. Gunn and others, a number of ideas have been noted in terms of dealing with active and former limestone quarries. The specification of the project, in terms of the objectives of the restoration blasting were described and are taken into account. The issues of landform design, the appraisal of the site, the construction of rock landforms as for example landscape screens has been considered.

The ideas and techniques related to face sealing have been taken into account in terms of treating the faces of proposal for quarry restoration. Habitat reconstruction ideas design techniques which were introduced by Dr. Gunn and others in order to bring proposed sites to a nature conservation after-use following mineral extraction activities such as blasting, haulage *etc.* This may be described as the simulation of natural processes.

Most of the above findings are potentially applicable throughout Libya, and in particular for the proposed potential after-use of Libyan quarry sites (Chapter 6, Figure No. 13).

Bradshaw and Chadwick, (1980), have focused on the restoration of land by the implementation of process to enhance the ecological potential for the reclamation of derelict and degraded land of which the quarries are a part.

The authors introduced the major problems of exploited land in different ways, and they provided the potential solutions for a range of common problems of degraded land. The solutions presented for most Libyan cases, will be applied with slight modifications taking into account the differences in the weather, the soil structure, the local works and their requirements, and the requirements of local people.

Coppin & Bradshaw (1982) introduced important aspects of restoration strategies and procedures, which were very relevant to the research aims and requirements of the present work. This is in terms of basic guidelines on land reclamation methods for modern quarry and non-metal open-cast sites. The publication was a primary contribution to this research, as it is useful to ecologists, landscape architects, and also both managers and lay people, who are not specialists in reclamation but require some guidance on how reclamation can proceed.

The publication by Bradshaw, Goode and Thorpe, (1986) *Ecology and Design in Landscape* influenced the research in terms of the application of the naturalistic plantations and the potential for utilising native plant species in restoration projects.

The major report by the Land Use Consultants (1992) (*Amenity reclamation of mineral workings*) presents a number of amenity restoration options for after-use as a part of the derelict and disturbed land restoration. The procedures and examples take into account the varied circumstances of the site including weather and climate, and the cultural requirements of the local people and their aspirations for the future.

Whilst the research project does not seek to cover in detail the ecological and procedural, aspects of quarry restoration, relevant references in the literature provide a useful background context to the study.

These include work dealing with contaminated and degraded land such as Buckley (Ed.) (1989), Gilbert and Anderson (1998), and Harris, Birch and Palmer (1996). Much of the available literature refers primarily to the situation in the UK or at least in Western Europe. Inspection of these key texts shows that whilst the principles are frequently relevant and transferable, the specific details and context may be radically different.

Restoration works and projects in the USA such as documented by the Society for Ecological Restoration include the remediation and re-creation of vegetation and communities of 'dry lands' such as prairie. The case studies presented in texts such as Jordan, Gilpin and Aber (Eds.) (1987) for example, are often relevant and informative for a Libyan situation.

Generally it was found that whilst there is an extensive literature on these topics in the UK and Western European situations, and also in North America, few if any academic papers or texts relate to North Africa in general or to Libya in particular. Furthermore, the base-line environmental and cultural information that is essential for a full understanding of such a topic, is generally only available in Arabic language. It was therefore necessary to extract a considerable body of such information and to present the translated form for the first time in English here.

1.2. The Aims of the Research

The overall research aim was to improve understanding of the issues and opportunities relating to the restoration of limestone quarries in Libya.

The specific aims of the research are:

1. To review the planning process for opening and extending limestone quarries in both Libya and the UK.
2. To compare and contrast the Environmental Impact Assessment procedures operating within the two countries.
3. To assimilate the approaches to limestone exploitation used throughout history in Libya and to use that information to modify approaches currently used in the UK and elsewhere.
4. To consider the various options for the after-use of defunct limestone quarries in the UK and to assess their relevance to application in Libya.

5. To take ideas on quarry restoration from the UK and adapt them to meet the cultural and environmental conditions prevalent in Libya.

6. To assess the overall approaches to environmental problems associated with mineral extraction in Libya and to make recommendations for their restoration.

1.3. The Objectives of the Research

The specific objectives of the research are to:

1. Critically review the relevant literature and other information sources.

2. Identify two suitable case-study quarry sites for detailed investigation----one in Libya, one in the UK.

3. Provide an overview of current, relevant, environmental impact assessment practice in the two countries.

4. Present an overview of current restoration techniques for beneficial after-use of quarry sites in the two countries.

5. Give an overview of the numbers and types of sites restored or planned for restoration to recreational or conservation after-use.

6. To present the Libyan scenario in the context of the land-use history of the area, and the state of the Libyan environment.

1.4. Rationale

Limestone quarrying and cement manufactures are recognised as having huge potential impact on both the environment, and on local people (Bradshaw and Chadwick, 1980; Coppin and Bradshaw, 1982; Harris, Birch and Palmer, 1996). This impact, and the environmental impact assessment process, will be considered with reference to case studies *etc.*, at sites both in Libya and in the UK.

The process of environmental impact assessment (Land Use Consultants, 1996; Harris, *et al.* 1996) will be compared in the two countries, and the applicability and transferability of ideas and procedures considered. Lee and George (Eds.) (2000), and Barrow (1997) have considered the potential for such applications and transference. However, for obvious political and economic reasons, there has been little research or writing on such matters with specific reference to Libya.

The after-use of post-industrial sites is now a major consideration in western economies such as the UK and the USA (Land Use Consultants, 1992 and 1996). In particular, not only the adverse affects are considered important, but the potential after-use for recreational and conservation functions are increasingly highlighted (Land Use Consultants, 1996; Moffatt and McNeill, 1994). Gunn *et al.* (1997) have considered the potential for more effective restoration of former limestone quarry sites in the UK, and aspects of this research could be usefully transferred to applications in North Africa.

These issues become increasingly relevant to emerging economies, as communities become more wealthy and have increased expectations of both environmental and leisure quality. Furthermore, as industrial and post-industrial landscapes become more widespread, their relevance and potential will also be increasingly considered (Bradshaw, 1987; Gilbert and Anderson, 1998). So far, there has been little work undertaken in this area in North Africa generally, and in Libya in particular.

This area of research is directly related to issues of sustainability, environmental management, and of tourism and leisure management.

Chapter 2. Methodology

2.1. Methodology

A critical review of the relevant literature and methodologies was carried out. A detailed evaluation of environmental impact assessment methodologies and procedures (in both Libya and the UK) was undertaken. Appropriate models for planning and impact assessment in Libya, and in the UK were considered, assessed and critically evaluated. Further development of these models forms the basis of the final, phase of this research.

Information on the general background to the research topic was gathered from both Libya and the UK.

Case study sites were identified in Libya and the UK, and contact made with the appropriate personnel at the sites. Relevant information and data were collected from the case study sites.

Information from the case studies and from other locations (50-100 sites in each country) was collated in an appropriate form, on map bases and in suitable computer databases, for an evaluation and for presentation. Relevant information on aspects of nature conservation and on leisure/recreation management was gathered. The information/data were rigorously interrogated and the research findings evaluated.

The degree to which the current systems applied in the UK are transferable to Libya was critically considered.

The standard models of planning procedures in the UK and in Libya were critically compared and contrasted. This was within the context of environmental audit and environmental management systems such as ISO14001and BS 7750 and in parallel to this, impact assessment models elsewhere in the emerging economies of the world were investigated.

Following critical analysis of the above, new models are presented which are appropriate to environmental impact assessment, environmental planning, and environmental management procedures in the limestone and cement industries of Libya.

Finally, some ideas are presented which integrate the selection of appropriate procedures with the processes of site after-use and rehabilitation. These ideas are based on established practice at case-study locations in the UK, and focus in particular, on the potential for habitation, leisure, farming and nature conservation, after-use. The application of these ideas is set in the context of the emerging economic regeneration of Libya.

The appropriateness and potential benefits to be gained through the transfer of ideas from the UK and other countries are discussed throughout this thesis.

Chapter 3. Historical and Geographical overview of Libya

3.1. A Summary of Libyan history and geography

This section is an introduction to the history and the geography of Libya. It considers the impact of earlier civilisations on various Libyan regions through the use of available limestone to construct cities and for domestic uses.

3.1.1. Early Libyan History

Archaeological evidence indicates that from at least the eighth millennium BC. Libya's coastal plain shared in a Neolithic culture, which was common to the whole Mediterranean littoral zone to the south, in what is now the Sahara Desert. Nomadic hunters and herders skilled in the domestication of cattle and cultivation of crops roamed a vast, well-watered savannah that abounded in game and provided pastures for their stock. Their culture flourished until the region began to desertify after 2000 BC. Scattering before the encroaching desert and invading Berber horsemen, the savannah people migrated into the Sudan and Chad or were absorbed by the Berber culture.

The origin of the Berbers is a mystery, the investigation of which has, to date, produced an abundance of educated speculation but no solution. Archaeological and linguistic evidence strongly suggests southwestern Asia as the point from which the ancestors of the Berbers may have begun their migration into North Africa early in the third millennium BC. Over the succeeding centuries they extended their range from Egypt to the Niger Basin. Caucasians of predominantly Mediterranean stock, the Berbers present a broad range of physical types and speak a variety of mutually unintelligible dialects that belong to the Afro-Asiatic language family. They have never had a sense of nationhood and have historically identified themselves in terms of their tribe, clan, and family. Collectively, Berbers refer to themselves simply as *imazighan,* to which has been attributed the meaning "free men".

Inscriptions found in Egypt dating from the Old Kingdom (*ca.* 2700-2200 BC) are the earliest known testimony of the Berber migration and also the earliest written documentation of Libyan history. At least as early as this period, troublesome Berber tribes, one of which was identified in Egyptian records as the Levu (or "Libyan"), were raiding eastward as far as the Nile Delta and attempting to settle there. During the Middle Kingdom (*ca.* 2200-1700 BC.) the Egyptian pharaohs succeeded in imposing their overlordship on these eastern Berbers and extracted tribute from them. Many Berbers served in the army of the pharaohs, and some rose to positions of importance in the Egyptian State. One such Berber officer seized control of Egypt in about 950 BC and, as Shishonk I, ruled as pharaoh. His successors of the twenty-second and twenty-third dynasties--the so-called Libyan dynasties (*ca.*945-730 BC.) are also believed to have been Berbers. The usage of limestone blocks was intensive during the ancient Egyptian and Shishonkian era. (The Official Organisation of Libyan History, 1977, Trans)

3.1.2. Tripolitania and the Phoenicians

Enterprising Phoenician traders were active throughout the Mediterranean area before the Twelfth Century BC. The depots that they set up at safe harbours on the African coast to service, supply, and shelter their ships were the link in a Maritime chain reaching from the Levant to Spain. Many North African cities and towns originated as Phoenician trading posts, where the merchants of Tyre (in present-day Lebanon) eventually developed commercial relations with the Berber tribes and made treaties with them to ensure their co-operation in the exploitation of *raw materials*. By the fifth century BC., Carthage, the greatest of the overseas Phoenician colonies, had extended its hegemony across much of North Africa, where a distinctive civilisation, known as Punic, came into being. Punic settlement on the Libyan coast included Oea (Tripoli), Leptis Magna (later Libdah), and Sabratah, in an area that came to be known collectively as Tripolis, or "Three Cities". Governed by a mercantile oligarchy, Carthage and its dependencies cultivated good relations with the Berber tribes in the hinterland, but the city-state was essentially a maritime power whose expansion along the western Mediterranean coast drew it into a confrontation with Rome in the third century BC.

Tripolitania was assigned to Rome's ally, the Berber King of Numidia. A century later, Julius defeated the Carthaginians in the long Punic Wars (264-241 and 218-201 BC.) Rome reduced Carthage to the status of a small and vulnerable African state at the mercy of the Berber tribesmen. Fear of a Carthaginian revival however, led Rome to renew the war, and Carthage was destroyed in 146 BC. Caesar deposed the reigning Numidian King, who had sided with Pompey (Roman general and statesman, and rival of Julius Caesar) in the Roman civil wars, and annexed his extensive territory to Rome, organising Tripolitania as a Roman province.

The influence of Punic civilisation on North Africa remained deep-seated. The Berbers displayed a remarkable gift for cultural assimilation, readily synthesising Punic cults with their folk religion. The Punic language was still spoken in the towns of Tripolitania and by Berber farmers in the coastal countryside in the late Roman period.
(The Official Organisation of Libyan History, 1977, Trans)

3.1.3.Cyrenaica and the Greeks

The Phoenician, Minoan and Greek seafarers had for centuries probed the North African coast, which at the nearest point lay 300 kilometres from Crete, but systematic Greek settlement there began only in the seventh century BC, during the great age of Hellenic overseas colonisation. According to tradition, emigrants from the crowded island of Crete there commanded by the oracle at Delphi (Greek City) to seek a new home in North Africa. In 631 BC they founded the city of Cyrene. The site to which Berber guides had led them was in a fertile highland region about 20 kilometres inland from the sea at a place where, according to the Berbers, a "hole in the heavens" would provide ample rainfall for the colony.

Within 200 years of Cyrene's founding (See Figure No. 1), four more important Greek cities were established in the area of limestone deposits as the main material for building the cities: Barce (Al Marij); Euhesperides (later Berenice, present-day Benghazi); Teuchira (late Arsinoe, present-day Tukrah); and Apollonia (Susa), the port of Cyrene. Together with Cyrene, they were known as the Pentapolis (Five Cities). Often in competition, they found co-operation difficult even when confronted by common enemies.

Figure 1. The settlement at Cirene to show the way in which Greek and Roman builders utilised the former quarry site

From Cyrene, the mother city and foremost of the five, was derived the name of Cyrenaica for the whole region.

The Greeks of the Pentapolis resisted encroachments by the Egyptians from the east as well as by the Carthaginians from the west, but in 525 BC the army of Cambyses (son of Cyrus the Great, King of Persia), fresh from the conquest of Egypt, overran Cyrenaica. For the next two centuries the area remained under Persian or Egyptian rule. Alexander the Great was greeted by the indigenous Greek population when he entered Cyrenaica in 331 BC. When Alexander died in 323 BC, his empire was divided among his Macedonian generals. Egypt, with Cyrene, went to Ptolemy, a general under Alexander who took over his African and Syrian possessions; the other Greek city-states of the Pentapolis retained their autonomy. However, the inability of the city-states to maintain stable governments led the Ptolemaic royal house to take control. Ptolemy Apion, the last Greek ruler, bequeathed Cyrenaica to Rome, which formally annexed the region in 74 B C and joined it to Crete as a Roman province.

The economic and cultural development of the Pentapolis was unaffected by the turmoil its political life generated. The region grew rich from grain, wine, wool, and stock breeding and from *Silphium*, a herb that grew only in Cyrenaica and was regarded as an *aphrodisiac.* Cyrene became one of the greatest intellectual and artistic centres of the Greek world, famous for its medical school, learned academies, and architecture. The latter included some of the finest examples of the Hellenistic style. The Cyrenaics, a school of thinkers who expounded a doctrine of moral cheerfulness that defined happiness as the sum of human pleasures, also made their home there and took inspiration from the City's pleasant climate.(The Official Organisation of Libyan History, 1977, Trans)

3.1.4. Libya and the Romans

For a long period, Tripolitania and Cyrenaica were prosperous Roman provinces and part of a cosmopolitan state whose citizens shared a common language, legal system, and Roman identity.

Roman ruins like those of Leptis Magna, extant in present-day Libya, attest to the vitality of the region, where populous cities and even smaller towns enjoyed the amenities of urban life -- the forum, markets, and baths -- found in every corner of the Roman Empire.

This history of the Roman Empire gives a useful insight into the use of limestone for establishing cities (many of which are still extant), and is strong evidence for the importance of limestone exploitation. Merchants and artisans from many parts of the Roman world established themselves in North Africa, but the character of the cities of Tripolitania remained decidedly Punic and, in Cyrenaica, Greek. Tripolitania was a major exporter of olive oil, as well as being the main port for the gold and slaves conveyed to the coast by Garamentes, while Cyrenaica remained an important source of wines, drugs, and horses. The bulk of the population in the countryside consisted of Berber farmers, who in the west were thoroughly "Punicized" in language and customs.

Although the African provinces profited as much as any part of the empire from the imposition of the Pax Roman, the region was not without strife and threat of war. Only near the end of the first century AD did the army complete the pacification of the Sirtica, a desert refuge for the barbarian tribes that had impeded overland communication between Tripolitania and Cyrenaica. For more than two centuries thereafter, commerce flowed safely between markets and ports along a well-maintained road system, and sea-lanes. Roman forces that also guaranteed the security of settled areas against incursions policed these by desert nomads. The vast territory was defended by one locally recruited legion (5,500 men) in Cyrenaica and the elements of another in Tripolitania, reinforced by tribal auxiliaries on the frontier. Although expeditions penetrated deep into Fezzan, in general Rome sought to control only those areas in the African provinces that were economically useful or could be garrisoned with the manpower available. (The Official Organisation of Libyan History, 1977, Trans)

3.1.5. Cyrenaica and the Jewish community

Under the Ptolemies, Cyrenaica had become the home of a large Jewish community, whose numbers were substantially increased by tens of thousands of Jews deported there after the failure of the rebellion against Roman rule in Palestine and the destruction of Jerusalem in AD 70. Some of the refugees made their way into the desert, where they became nomads and nurtured their fierce dislike of Rome. They converted to Judaism many of the Berbers with whom they mingled, and in some cases whole tribes were identified as Jewish. In AD 115 the Jews raised a major revolt in Cyrenaica that quickly spread through Egypt back to Palestine. The uprising was put down by AD 118, but only after Jewish insurgents had laid waste to Cyrenaica and sacked the city of Cyrene. Contemporary observers counted the loss of life during those years at more than 200,000 and at least a century was required to restore Cyrenaica to the order and prosperity that had meanwhile prevailed in Tripolitania.

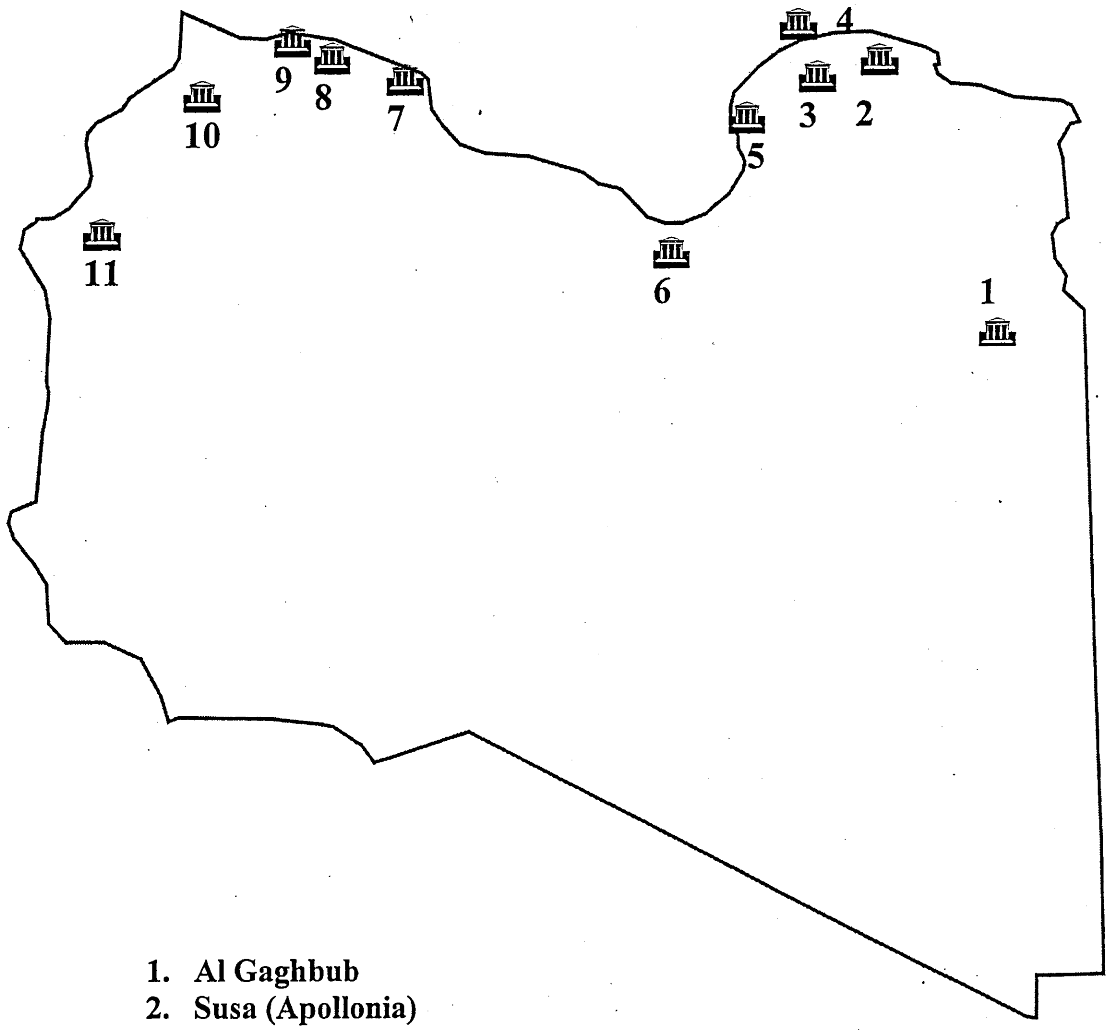
As a part of his reorganisation of the empire in 300 AD, the Emperor Diocletian separated the administration of Crete from Cyrenaica and in the latter formed the new provinces of Upper Libya and Lower Libya, using the term *Libya* for the first time as an administrative designation. With the definitive partition of the empire in 395 AD, the Libyans were assigned to the easterner empire; Tripolitania was attached to the westerner empire.

By the beginning of the second century, Christianity had been introduced among the Jewish community, and it soon gained converts in the towns and among slaves. Rome's African provinces were thoroughly Christianised by the end of the fourth century, and inroads had been made as well among the Berber tribes in the hinterland. From an early date, however, the churches in Tripolitania and Cyrenaica developed distinct characteristics that reflected their differing cultural orientations. The former came under the jurisdiction of the Latin patriarch, the bishop of Rome, and the latter under that of the Coptic (Egyptian) patriarch of Alexandria. In both areas, religious dissent became a vehicle for social revolt at a time of political deterioration and economic depression.

Invited to North Africa by a rebellious Roman official, the Vandals (a Germanic tribe) crossed from Spain in 429 AD. They seized power and, under their leader, Gaiseric established a kingdom that made its capital at Carthage. Although the Roman Empire eventually recognised their overlordship in much of North Africa, including Tripolitania, the Vandals confined their rule to the most economically profitable areas. There they constituted an isolated warrior caste, concerned with collecting taxes and exploiting the land but leaving civil administration in Roman hands. From their African base they conquered Sardinia and Corsica and launched raids on Italy, sacking Rome in 455 AD. In time however, the Vandals lost much of their warlike spirit, and their kingdom fell to the armies of Belisarius, the Byzantine general who in 533 AD. began the re-conquest of North Africa for the Roman Empire.

Effective Byzantine control in Tripolitania was restricted to the coast, and even there the newly walled towns, strongholds, fortified farms, and watchtowers (constructed of limestone rock) called attention to its tenuous nature. The region's prosperity had shrunk under Vandals. The inhabitants had sought the protection of tribal chieftains and, having grown accustomed to their autonomy, resisted re-assimilation into the imperial system. Cyrenaica, which had remained an outpost of the Byzantine Empire during the Vandal period, also took on the characteristics of an armed camp. Unpopular Byzantine governors imposed burdensome taxation to meet military costs, but towns and public services - including the water system -- were left to decay. Byzantine rule in Africa did prolong the Roman ideal of imperial unity there for another century and a half, and prevented the ascendancy of the Berber nomads in the coastal region.
(The Official Organisation of Libyan History, 1977, Trans)

Map No. (1) The Ancient Cities of Libya



1. Al Gaghbub
2. Susa (Apollonia)
3. Shahat (Cirene or Cyrene)
4. Tolmetha
5. Benghazi (Euhesperides or Berenice)
6. Sirte
7. Libdah (Leptis Magna)
8. Tripoli (Oea) or (Tripolitania)
9. Sabratah
10. Nalot
11. Kadamiss

3.1.6. Libya (Islam and the Arab)

Libya as a part of the North African region, adjacent to the Arabian Peninsula, and by the middle of the seventh century (AD. 642), had received the new monotheistic religion of Islam that was introduced by the Prophet Mohammed and his followers from the land of the Arabian Peninsula. (www.islamicnet.1998. Trans)

Islamic rulers therefore exercised both temporal and religious authority and the Islamic social system collectively formed the House of Islam (Dar al Islam).

Within a generation, Arab armies had carried Islam Civilisation north and east from Arabia and westward into North Africa. In 642 AD. Amar Ibn al As, an Arab general under Caliph Omar, conquered Cyrenaica, establishing his headquarters at Barce. Two years later, he moved into Tripolitania, where, by the end of the decade, the isolated Byzantine garrisons on the coast were overrun and Arab control of the region consolidated. Uqba bin Nafi, an Arab general under the ruling Caliph (Amir, Head of Islamic States), invaded southwest Fezzan in 663 AD., forcing the capitulation of Germa. However, stiff Berber resistance in Tripolitania had slowed the Arab advance to the west, and efforts at permanent conquest were resumed only when it became apparent that the Magrib (the western part of North Africa) could be opened up as a theatre of operations in the Muslim campaign against the Byzantine Empire. In 670 AD. the Arabs surged into the Roman province of Africa, where Uqba founded the city of Kairouan (present-day Al Qayrawan) as a military base for an assault on Byzantic-held Carthage. The Arabs cautiously probed the western Maghrib and in 710AD. invaded Morocco, carrying their conquests to the Atlantic. In 712 AD they mounted an invasion of Spain (called Andalusia), the Maghrib (including Tripolitania), and Cyrenaica were systematically organised under the political and religious leadership of the Umayyad caliph of Damascus. (www. libyanet, 1997)

Arab rule in North Africa as elsewhere in the Islamic world in the eighth century had as its ideal the establishment of political, economic and religious unity under a caliphate (the office of the Prophet's successor as supreme earthly leader of Islam).

It governed in accord with sharia (a legal system) administered by qadis (religious judges) to which all other considerations, including tribal loyalties was subordinated. The sharia was based primarily on the Quarn and the Hadith (Prophet's speech) and derived in part from Arab tribal and market law.

During these days, the Arabs had established their own cities with, mosques, schools, hospitals, bridges, dams, roads and baths. The early Arab population generally lived in tents to cope with the severe conditions of life in and around the desert, and the often nomadic or semi-nomadic existence. Some of them lived close to or in the Roman Empire itself. This probably helped them to acquire ideas of construction using minerals, and the creation of planned cities. (Arabian Congress, 1989. Trans)

The Arab tribes and armies, who lived in the Libyan region, formed an urban elite in North Africa, where they had come as conquerors and missionaries, not as colonists. Their armies had travelled without women and married among the indigenous population, transmitting Arab culture and Islamic religion over a period of time to the townspeople and farmers. Although the nomadic tribes of the hinterland had stoutly resisted Arab political domination, they rapidly accepted Islam. (The Official Organisation of Libyan History, 1977. Trans)

After the Arab conquest, North Africa was governed by a succession of amirs (commanders) who were subordinate to the caliph in Damascus and, after 750, in Baghdad. In 800 AD. the Abbasid caliph Harun ar Rashid appointed as amir Ibrahim Ibn Aghlab, who established a hereditary dynasty at Kairouan (Al Qayrawan) that ruled Ifriqiya and Tripolitania (North Africa, Libya & Tunisia in particular) as an independent state that was subject to the caliph's spiritual jurisdiction and that nominally recognized him as its political suzerain. The Aghlabid amirs repaired the neglected Roman irrigation system, rebuilding the region's prosperity and restoring the vitality of its cities and towns with the agricultural surplus that was produced.

The uses of the limestone by the Arabs were intensive. Some of this was re-use of stone already shaped and manufactured for use in the Roman and Greek temples, by converting them into mosques and schools on the same site, they also used small rocks mixed with mud clay and gypsum to build their houses and dams.

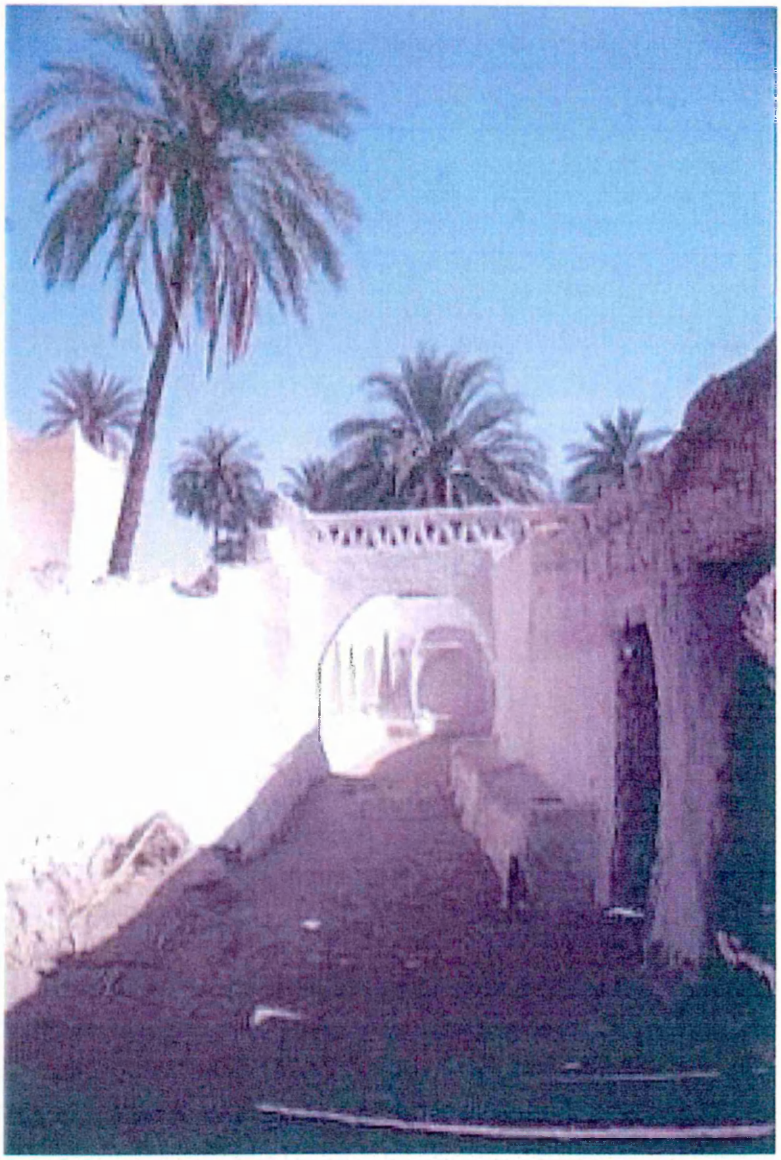


Figure 2. Using the limestone in traditional buildings

There were two ways of extracting limestone blocks, first, they used to cut the blocks by making tiny grooves surrounding a big piece of rock, and filling these grooves with water mixed with concentrated vinegar for two or three days, then they moved these blocks with the help of animals. The other way of limestone block extraction is by the same previous method but using olive oil and fire instead of water and vinegar inside the grooves to break the rocks into small pieces. (Arabian Congress, 1989. Trans)

This history has revealed the importance of the limestone in earlier civilisations, and the consequent impacts of the extraction and use of limestone during past-times.

3.2. Geography

Libya is situated in the middle of the North African coast, surrounded by Egypt and Sudan to the east, Tunisia and Algeria to the west, and Chad and Niger to the south. It has an area about 1,760,000 square kilometres; consisting mainly of desert. Its landward boundaries are 4,345 kilometres long, with a Mediterranean coastline of nearly 1,800 kilometres. The coastal waters include a twelve nautical-mile maritime claim, with the disputed Gulf of Sidra. Libya is fourth in area among the countries of Africa, and fifteenth among the countries of the World. The Mediterranean coast and the Sahara Desert are the country's most famous natural features. There are several highlands but there are no true mountain ranges except in the large empty Southern Desert near the Chadian border, where the Tibesti Massif rises to over 2,200 metres.

A relatively narrow coastal strip and the highland steppes immediately south of it are the most productive agricultural regions. Farther south a pastoral zone of sparse grassland gives way to the broad Sahara Desert. A barren wasteland of rocky plateau and sand, it supports minimal human habitation, and agriculture is possible only in a few scattered oases.

Between the productive lowland agricultural zones lies the Gulf of Sidra, where along the coast a stretch of 500 kilometres of wasteland desert extends northward to the sea. This barren zone is known as the Sirtica. (Middle of Libya). To the west of Sirtica and along the shore of Tripolitania (Western Libya) which is situated next to it for more than 300 kilometres, coastal oases alternate with sandy areas and lagoons. Inland from these areas lies the Jifarah Plain a triangular area of about 15,000 square kilometres, About 120 kilometres inland the plain terminates in hills that rises to form the Jabal Nafusah (Mountain), a plateau with a height of up to 1,000 metres.

In the eastern part of Libya, which is called CYRENAICA (eastern Libya), there are fewer coastal oases, and the Marj Plain - the lowland area corresponding to the Jifarah Plain of Tripolitania (western Libya)-covers a much smaller zone. The lowlands form a crescent about 220 kilometres long between Benghazi and Darnah and extend inland for a maximum of 50 kilometres. Elsewhere along the Cyrenaican coast, the precipice of an arid plateau reaches to the sea.

Behind the Marj Plain, the land rises suddenly to form Jabel al Akhdar (Green Mountain), so called because of its leafy cover of pine (*Pinus brutea - Pinus halepensis*), juniper (*Juniperus phonicea*), cypress (*Cupressus sempervirens- Pastacia lentiscus*, *Cupressus sarcopoterium spinosum*, *Cupressus quercus coccifera*) and wild olive (*Olea europaea*).

The underlying geology of the plateau is limestone, and it has maximum altitudes of about 900 metres. From Jabel al Akhdar, Cyrenaica extends southward across a barren grazing belt that gives way to the Sahara Desert which extends still farther south-west across the Chad frontier

Before the revolution in 1969, the southern area was known as Fessan, but after that the revolutionary government officially changed the regional designations of Tripolitania to Western Libya, of Cyrenaica to Eastern Libya and of Fezzan to Southern Libya. (www.libyaourhome.com)

3.2.1. The Climate

Up to five different climatic zones, have been recognised within Libya, but the major climatic influences are Mediterranean and Saharan. In most of the coastal lowland, the climate is typical Mediterranean, with warm summers and mild winters. Rainfall is scant, and the dry climate results in a year-round ninety-eight percent visibility and clarity, except in a few areas in southern Libya affected by the sandstorms.

The weather is cooler in the highland, and frosts occur at maximum heights. In the desert interior the climate has very hot summers and extreme diurnal temperature ranges.

Less than two percent of the national territory receives enough rainfall for settled agriculture, the heaviest precipitation occurring in the Jabel al Akhdar zone of Cyrenaica (Eastern Libya) where annual rainfall of 400 to 600 millimetres is recorded. All other areas of the country receive less than 400 millimetres and in the Sahara 50 millimetres or less occurs. Rainfall is often erratic, and an extreme drought may extend over two growing seasons. (The Libyan Environmental Common Institution, 1991)

3.2.2. The forest and the vegetation of north-east Libya

The forests and associate plant communities were the main components of the natural environment of the higher rainfall areas which occurred in the northeast of Libya the local name for this zone was the Green Belt.

These forests or the Green Belts were exposed to intensive exploitation through the two millennia. This led to its general deterioration through a reduction of the area covered by forest tree and by herbs, a reduction in density a lowering of the crown cover in many areas. Besides this, the lack of maintenance of the old hillsides, the old masonry stone check dams on the agricultural slopes, and in wadi (valley) beds, caused their partial destruction and led to the loss of their productive functions. Also, the associated agricultural lands, which are under exploited, are not being used, at the present, according to their capability.

Under the influence of such destructive factors, severe erosion has affected an area of land, which covers about 60 percent of the Green Belt in northeast of Libya, where the study site is located. These areas have lost most of their soil, to expose bedrock on more than 40 percent of the land surface. The landscape is now characterised by these typical karst features, (limestone structures) (National Parks projects N. E. Libya, 1984).

In addition, the former deep fertile soils were cut and washed away by gullies developed along channels of old conservation structures. Many of the wadi beds, especially in the coastal zones, have been subjected to bank and channel erosion, as well as severe grazing by livestock.

The above problems are rife in N. E. Libya, and have led to vegetation dominated by plants of which are typically able to survive in such adverse land conditions. The vegetation in northeast Libya is mostly within the evergreen forest zone (from Maquis to Garigue), except for inland areas of which are well away from the coastline (Steppe). Some of the evergreen forest shrubs may grow as high as 3-4 m, with low scrub around 1-2 m (Figure No. 3).

Figure 3. Evergreen forest scrub

These play an important part in building up the soil and protecting herbaceous species. Within this community many annuals, and herbaceous perennials with deep root systems or with swollen storage organs below ground, establish themselves. In the dry hot summer the aerial stems die and underground parts remain dormant until the return of rains in autumn (See Appendix No.2).

The forests covered between 50 and 80 percent of the land surface, of the Jabel Al Akhdar (Northeast Libya), the trees being single stemmed and the forest made up of only one or two species of trees. These are (*Juniperus phoenicea*) or (*Quercus*) which dominate all such Mediterranean regions. (Polunin and Huxley, 1992)

These trees grow on a diversity of soils such as calcareous brown soils and typical-isohumic brown red soils, and may occasionally form dense forests. More commonly they occur scattered within a landscape of low scrub, grassland and ground herbs. Oak dominated forests are rarely seen in their climax state, when they form very dense and dark woodlands up to 12-15m high with a shrub layer underneath which comprise of *Cistuses*, *Pistacia lentiscus*, *Arbutus pavarii*, *Rhus tripartita*. (See Appendix No. 2)

These communities provide the environmental and vegetation context for the main thrust of this study. Furthermore, the study site is located within a series of habitat-types, which may be classified as follows:

* **Steppe**
* **Garigue**
* **Maquis**
* **Woodland**

The above are essentially stages in a seral succession, both progressive or regressive, building up towards a climax community (woodland), or stages in a degenerate, degradation process (from woodland to steppe, via maquis and garigue) (www.libyanet. 1999).

3.2.3. Definitions and Examples

3.2.3.1. Steppe

Steppe may be defined as a treeless grassland, dominated by grasses, umbellifers, thistles and geophytes (plants having either underground tubers or bulbs).

This habitat-type may be either the result of degradation of a maquis or garigue vegetation community, by excessive burning or grazing, or of natural origin affecting the climatic conditions prevailing in the area. This is the case when the land can not support the growth of garigue or maquis vegetation. A typical example of this habitat type is the clay slopes found at neglected clay quarries which are dominated by the Esparto Grass (*Lygeum spartum*), Mediterranean Steppe Grass (*Stipa capensis*), and Goat Grass (*Aegilops geniculata*) (Figure No. 4).

Figure 4. ***Esparto*** **grass, which is very important in binding the clay soils and preventing erosion**

Consequently, the grass species play an important role in binding the clay soils in which they grow, thereby preventing erosion.

Some types of thistle species are very common in steppe habitats, and grow opportunistically on disturbed ground i.e. Horse Thistle (*Notobasis syriaca*), Clustered Carline Thistle (*Carlina involucrata*), Boar Thistle (*Galactites tomentosa*). Other species are adapted to surviving the summer months as subterranean tubers i.e. Asphodel (*Asphodelus aestivus*).

3.2.3.2. Garigue

Garigue is characterised by spring-flowering, aromatic shrubs, less than 1 m in height. It is typically found on rocky ground. Plants found in this environment are adapted to living in harsh conditions: low water availability, exposure to wind and shallow soil. They can be placed into three different categories, according to the strategies they adopt:

1. Perennial i.e. plants occurring all year round, and consequently has adaptations that enable water to be conserved. These adaptations include reduced leaves, extensive root system and aromatic oils. The evaporation of the latter cools down the plant, preventing excessive loss of water.

Examples:

Mediterranean Thyme (*Coridothymus capitatus*)
Yellow Kidney Vetch (*Anthyllis hormanniae*).
Mediterranean Heath (*Erica multiflora*)
Spurge (*Euphorbia dendroides*)
Olive-Leafed Germander (*Teucrium polium*)

2. Annuals i.e. Plants that survive the dry season as seeds and grow during the wet season.
Examples:
Edible Birdsfoot Trefoil (*Lotus edulis*) and, (*Coronilla scorpioides*)

3. Geophyte i.e. plants that survive the dry season as buried tubers or bulbs.
Examples:
French Daffodil (*Narcissus tazetta*).

3.2.3.3. Maquis

Maquis can be defined as a dense (usually evergreen) shrub community (Fig No. 3), where individual shrubs reach between 1-3 m in height. locally, this habitat develops on the sides and bottoms of dry valleys and at the foot of inland cliffs.
Typical plant species found in the region include:

Karob or Carob (*Ceratonia siliqua*) (Figure No. 5).
Olive (*Olea europea*) (Figure No. 6).
Lentisk (*Pistacia lentiscus*)
Olive-leaved Buckthorn (*Rhamnus oleiodes*).
Yellow Germander (*Teucrium flavium*).

(The Libyan Environmental Common Institution, 1991)

Figure 5. Karob or Carob (*Ceratonia silqua*)

Figure 6. Olive trees (*Olea europea*)

3.2.3.4. Woodland

Before human colonisation, evergreen woodlands were widespread over a significant area of the northeast of Libya. However, deforestation has reduced these woodlands to remnants, now found in the following areas: Ras Alhelal, Karsa, Lathron, Shahaat, and Labrak. The Oak (*Quercus*), and the Aleppo Pine (*Pinus halepensis*), dominated these woodlands. More recently established semi-natural woodlands exist (as found at Takniss). Although these were originally planted by local people the trees are now self-regenerating.

Woodlands of the Sandarac Gum tree (*Tetraclinis articulata*) no longer exist, although patches of maquis dominated by this species persist. The natural deciduous forests dominated by the Willows (*Salix alba* and *Salix pedicellata*) have been eradicated, and only males of the latter species remain, usually growing along watercourses. Woodlands of the Ash (*Fraxinus angustifola*) were eradicated in antiquity so that this species became extinct. It was later introduced at Takniss in 1975 (National Parks Projects North-east Libya, 1984).

3.3. Geology and Quarrying

3.3.1. Geological and stratigraphic distribution

High-grade limestone occurrences are found at various stratigraphic levels, and distributed throughout the country. In terms of geological age, the limestone occurrences have been observed from the Palaeozoic (580 million to 250 million years ago) to Recent.

The Palaeozoic and continental Mesozoic (290 million to 65 million years ago) deposits are confined mainly to the southern parts of the country. Some deposits occur in the Carboniferous sequences in southern Libya, however, their industrial exploitation is yet to be commercially assessed.

Practically all the high-grade limestone deposits, so far discovered by either exploration work or detailed investigation are confined to the northern half of the country.

These limestone occurrences represent various types of marine environment from deep-water pelagic to shallow littoral and lagoon. They are of Tertiary age (less than 65 million years ago).

Most of the limestones are fragmental but organic and chemically precipitated varieties including magnesium are not uncommon. Many limestone also contain significant proportions of detrital constituents like sand, clay *etc.*, and in quality they vary from pure limestone to dolomitic ones.

The stratigraphic correlation in various regions of the country is presented in Appendix No. 4 and the position regarding important limestone occurrences is mentioned in the due sections under the regions as follows:

*North-western region comprising mainly the older Tripolitania area and geologically representing Jefara coastal plain, Jabel Nafusa, Hamadah basin and northern Garaf uplift.

*North-central region comprising mainly the older Sirtica basin and Al Jufra area and geologically representing Sirte basin and Hun graben area.

*North-eastern region comprising mainly the older Cyrenaica and Al Jaghbub areas and geologically representing Jabel al Akhdar (green mountain) and As Sarir.

*South-western region comprising mainly the Fezzan area and geologically representing Murzug basin. (The Libyan Mining and Quarrying Procedures, 1985)

The study site is located in the north-eastern region of the country at Martubah in the Darnah area.

The Darnah area formations

The following geological formations and the corresponding chief rock types occur in the area. (After Zert, 1974)

Table 1. The Geological formations in Darnah Works area

Formation	*Lithologics*
Quaternary	Sabkhah Alluvial and coastal sediment.
Tertiary	Al Faidiyah Limestone Formation, calcarenite, calcilutite, clay to clayey limestone. Al Abraq Formation, Calcarenite, calcilutite, dolomitic. Al Bayda Formation, Algal limestone, calcarenite. Darnah Formation, Algal and coral limestone, nummulitic limestone. Apollonia Formation, Limestone, fine grained to microcrystalline, chalky with chert and bit substances.

Like other northern areas, the Darnah area is very rich in limestone occurrences and almost all formations contain interbedded clay and marl layers.

3.3.2. History of Quarrying for Limestone in Libya

Libya as a developing country seeking a more stable and affluent lifestyle (The Libyan Congress Statement, 1970.Trans.) is seeking to exploit, for the benefits of its people, those natural resources which it has within its boundaries.

The earliest settlers from the Greek, Roman periods established their cities, built of native limestone by cutting and excavating the blocks and building them into the attractive designs, as they required. This is evident in the remains of cities as Cyrene, Susah and Leptis-Magna, which have been further exposed through more recent excavations.

Following this active period of building on a grand scale with limestone dimension stone the local people, including the coming of Islam to the country, changed to creating local vernacular styles using surface stones, rubble-built, bound by lime mortar and with roof timbers of date-palms (See Figure No.7).

This development did not exploit quarrying of limestone, except on the small scale (2-4 ha), for nearly fifteen Centuries.

Since the Italian occupation in 1911, and because of the uncertain lifestyle and political circumstances, low level of economic activity due to the war between the Libyan Islamic Groups and the Italian troops, the transportation constructions were very simple in both design and execution. All materials such as aggregate, sand and paving stone used were of local origin and production.

The indigenous people used to build houses for themselves, or for their domestic animals, constructed of blocks of limestone together with branches of trees. They divided the date tree stems to use them as pillars to link and tie their constructions together.

The most important of the available building resources for these people was the limestone. Just as the lifestyle flourished, so the usage of limestone became diverse. On some occasions it was used as blocks, and at other times used as a powder, in the manufacture of cement and mortars.

Figure 7. Houses constructed of limestone blocks and branches of date palms

3.3.3. The Libyan Cement Industry

The contemporary Libyan Cement Industry has developed since the late 1960's, when recent and increasing developmental activity in Libya has increased the requirements of construction materials, especially cement. (Cement raw material of Libya, 1983. Trans.)

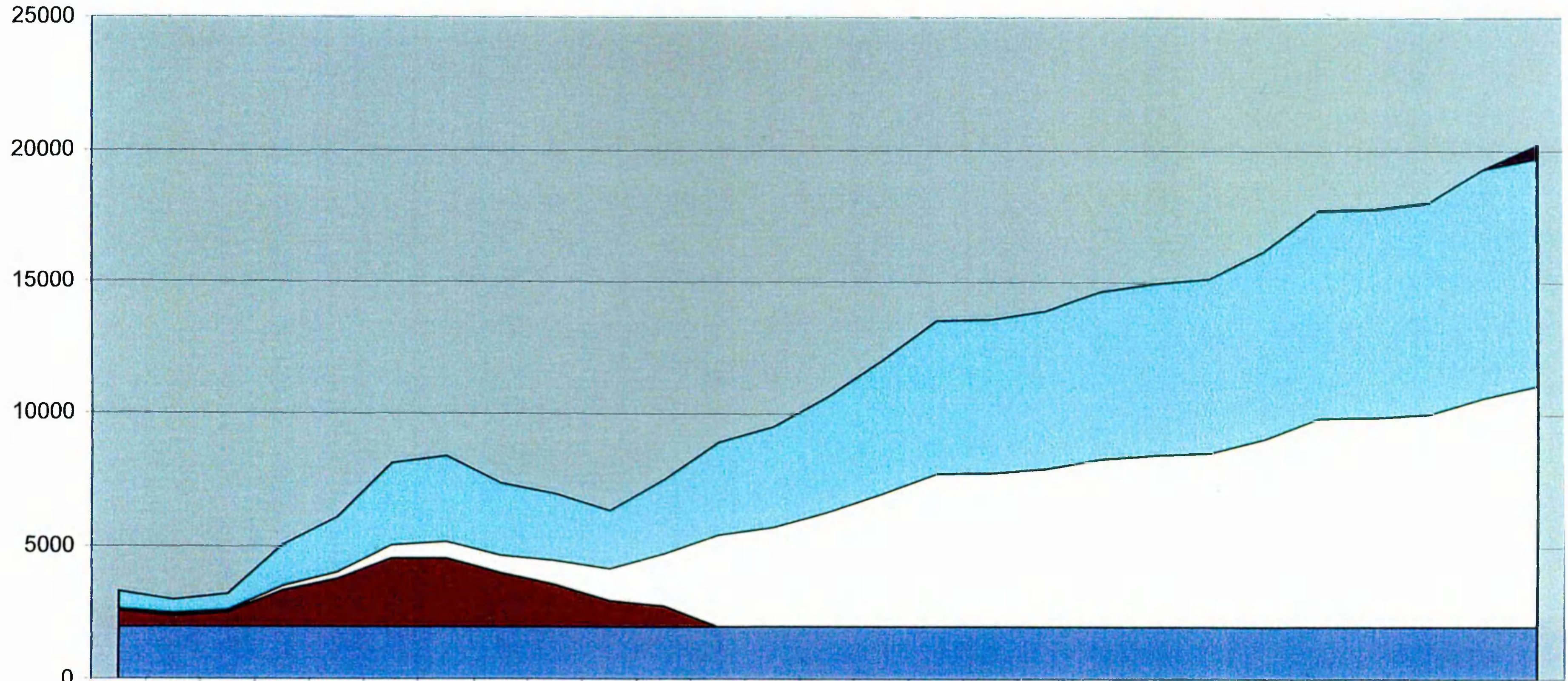
The developmental activities of a country often follow a continuous process and lead to a natural desire to achieve self-sufficiency in the production of essential raw materials. (Libyan Industrial Research Centre Report, 1990. Trans.)

The manufacture of cement is, in every sense, a basic industry and the establishment of cement manufacturing units is one of the first initial steps taken in a modern industrialised economy. (Libyan Industrial Research Centre Report, 1992. Trans.)

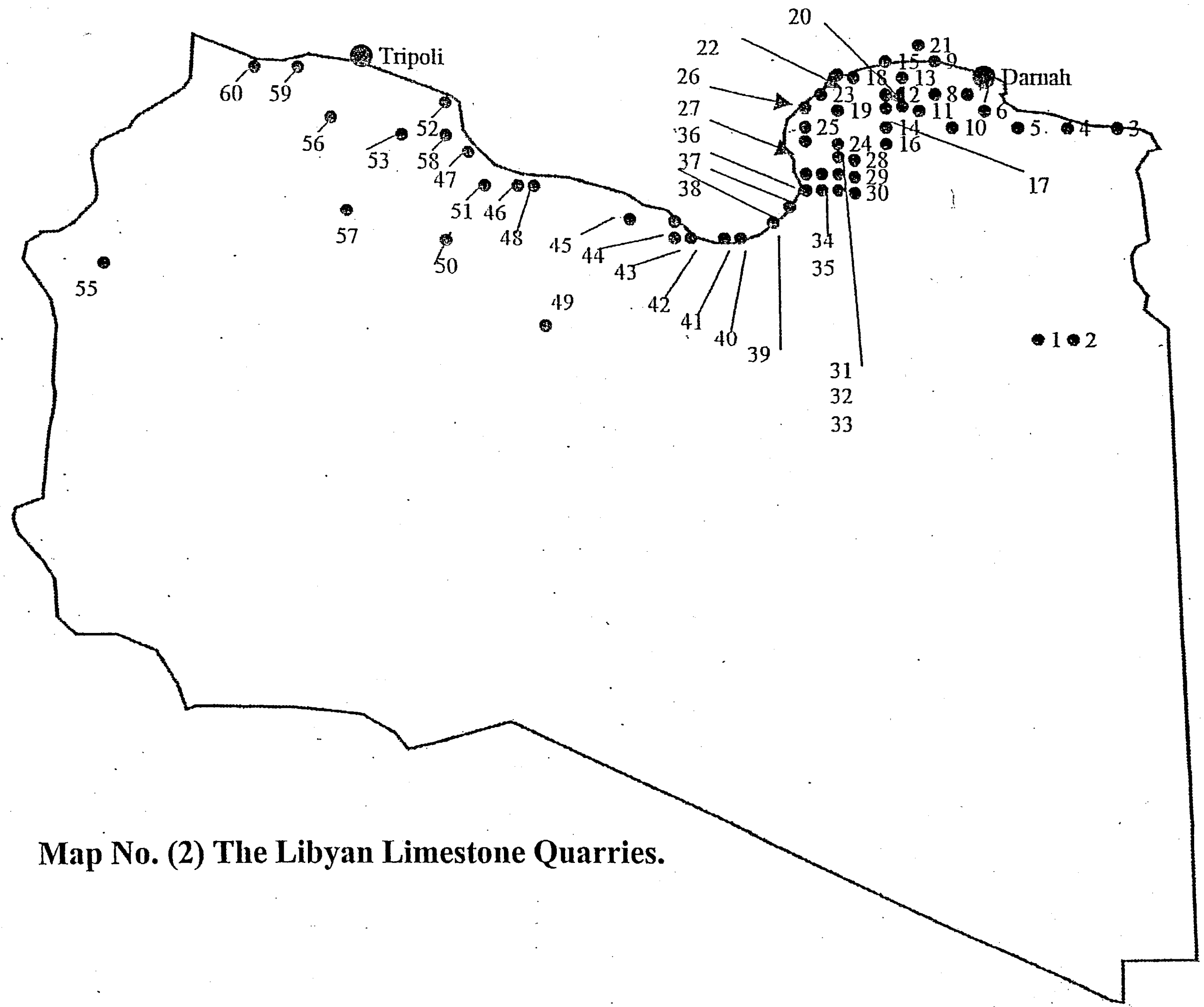
As noted, the Libyan cement industry is very recent in origin. Its first cement works came into being in 1968, at Al Khums, 150 km east of Tripoli. From then onwards, and since 1973, the industry has grown steadily and in (1998-2001) had a capacity of 8.5 million tonnes with additional 2 million tonnes, being added through new installation established by the Libyan Cement Company, and there is planning for another 3 million tonnes capacity in 2002 to 2007. (After Libyan Annual Report, 1998. Trans.)

Furthermore, the country is planning a many-fold increase in cement production in order to meet the ever-increasing demand. This is not only from the internal market for cement but also plans to export to the needy countries and as a part of co-operation with adjacent countries (Libyan Annual Report, 1992, Libyan Industrial Research Centre Report, 1990. Trans.) (Table 2) (Map No. 3) (Sanctions have prevented publication of further data).

Figure 8. Import, export and use of cement in Libya between 1969 & 1995



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Export t/y																											500
Use t/y	661	502	614	1543	2062	3081	3213	2702	2505	2194	2774	3475	3764	4330	5013	5776	5801	5965	6334	6488	6576	7099	7876	7902	8022	8652	8608
Products t/y	64	97	76	179	259	489	622	670	907	1211	2001	3475	3764	4330	5013	5776	5801	5965	6334	6488	6576	7099	7876	7902	8022	8652	9108
Imports t/y	597	405	538	1364	1803	2592	2591	2032	1598	983	773	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Years	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995



Map No. (2) The Libyan Limestone Quarries.

The Libyan Limestone Quarries on Map 2:

1- Al Gughbub Quarry No. 1.	21- Shahat Ancient Quarry.	41- Al Aqaylah Agg Quarry
2- Al Gughbub Qyarry No. 2.	22- Al Kufe Limestone Quarry	42- Qasr Sirt Quarry
3- Al Bardia Quarry.	23- Al Shaluni Limestone Quarry	43- Abu Hadi Agg Quarry
4- Tammemi Limestone Quarry.	24- Al Kharroba Aggregate	44- Bu Njim Building Stone
5- Al Bombah Building Stone Quarry.	25- Hawsh Al Hawwari Quarry	45- An Nufaliyah Quarry
6- Ommarzam Building Stone Quarry.	26- Tolmeta Ancient Quarry	46- Misratah Chalk Quarry
7- Martubah Limestone Quarry.	27- Tukra Aggregate Quarry	47- Misratah Building Stone
8- Al Naghah Limestone Quarry.	28- El Abiar Aggregate Quarry	48- Tawerghah Chalk Quarry
9- Sidi Khalid Building Stone Quarry	29- El Abiar Gypsum Quarry	49- Hun Gypsum & Chalk
10- Al Gubbah Building Stone Quary.	30- El Abiar Chalk Quarry	50- Al Qaddahiyah Quarry
11- Lamlodah Limestone Quarry.	31- Al Rajmah Quarry	51- As Sidadah Quarry
12- Al Faidiyah Limestone Quarry.	32- Benina Building Stone Quarry	52- Ra Elmanubia Quarry
13- Al Abrag Limestone Quarry.	33- Solluk Aggregate Quarry	53- Al Juma Quarry
14- Al Ghariga Building Stone Quarry	34- Zawiyat Masus Quarry	54- Ras El Kabir Quarry
15- North Al Bida Limestone Quarry.	35- Zawiyat Masus Building Stone	55- Hasnun Quarry
16- Gernada 1 B.S. Quarry.	36- Ajdabiya (A) Building Stone	56- Souk el Khamis Quarry
17- Gernada 2 B.S. Quarry.	37- Ajdabiya (B1) Building Stone	57- Bani Walid Quarry
18- Susah Aggregate Quarry.	38- Ajdabiya (B2) Building Stone	58- Libdah Limestone
19- Susah Ancient Limestone Quarry.	39- Ajdabiya Al Sahil Quarry	59- Azzaweya Building Stone
20- Moutain B.S. Quarry.	40- Al Washkah Quarry	60- Sabratah Ancient Quarry

Table 2. Cement plants in Libya and their production capacity

(after the Libyan Industrial Research Centre 1990)

Location of the unit	New unit/Expansion	Capacity. Tonnes/annum	Year of commissioning
1- Al Khums	a) First kiln	100,000	1968
	b) Extension	300,000	1974
2- Libdah (Al Khums 2)	New unit	1,000,000	1979
3- Benghazi	a) First kiln	200,000	1972
	b) First extension	400,000	1974
	c) Second extension	400,000	1976
4- Al Hawwari (Benghazi 2)	New unit	1,000,000	1978
5- Souk el Khamis	New unit	1,000,000	1977
6- Darnah (The case of study)	New unit	1,000,000	1983
7- Zliten	New unit	1,000,000	1983
8- Suknah (Al Jufrah)	New unit	1,000,000	1988
9- Wadi Al Shati	New unit	500,000	1980

From Table 2 it may be seen that the trend is to meet internal demand for cement, by increasing the domestic production. This objective of meeting demand by internal production has been achieved by expanding the existing units, establishing additional units, and improving the production in those units already operational (Table 2) (Fig. No. 8).

3.3.3.1. The Future of the Cement Industry in Libya

As in any developing country with considerable revenue, Libya is able to continue its growth. This includes improvement in and demand for cement production. Therefore, it may be seen from the evaluation of demand, and the corresponding indigenous cement capacity, that the present (1998-2001) installed capacity of ten million tonnes seems adequate. At optimal utilisation capacity of about 99.8 percent, the country's cement industry should be able to meet the present (1998-2001) demand of about eight million tonnes per annum. (Libyan Industrial Research Centre Report, 1998. Trans.)

From experience over the past decade, it is clear that there has been a phenomenal and many-fold increases in the economic developmental activities of the Country. The demand for cement cannot, therefore, be kept at the same level. In order to meet this ever-growing demand, it is necessary to increase domestic production. (Libyan Audit Organisation Report, 1985. Trans.) This means that several sites must be kept ready for exploitation, as and when, the cement capacity is required to be increased.

3.3.3.2. Raw Materials for Cement Manufacture in Libya

Libya is endowed with rich resources of the raw materials needed for cement manufacture. Several sites of potential importance have been located in the course of systematic geological mapping and are to be taken up for detailed investigation in stages in the future. Fortunately for the Cement Industry, most of the raw materials are available within the country both in abundant quantities and distributed widely in forms, which are relatively easy to exploit. (Libyan Industrial Research Centre Report, 1983. Trans.)

The conventional raw materials for cement manufacture are limestone, clay or laterite and fuels such as coal or oil. Normally a cement plant is located near the main raw material for cement manufacture i.e. limestone. This is in order to reduce the cost of transportation of limestone to the bare minimum since the economics are based on transport of about 1.6 tonnes of limestone, as against one tonne of finished cement. (Libyan Industrial Research Centre Report, 1977, 1980, 1983.)

The limestone quantity is worked out so as to provide proved reserves to support the cement plant for approximately fifty years, and possible reserves for any further extensions of the unit. The main planning is done in accordance with the recent Libyan publications.

Next to the limestone, clay consumption is about 20 per cent of the mix. Most of the cement plants, especially the large capacity plants, have their own clay mines. Clay and shales typically occur either fairly close by the limestone deposits or are found associated with limestone as inter-banding, lenses or pockets. (Libyan Industrial Research Centre Report, 1970. Trans)

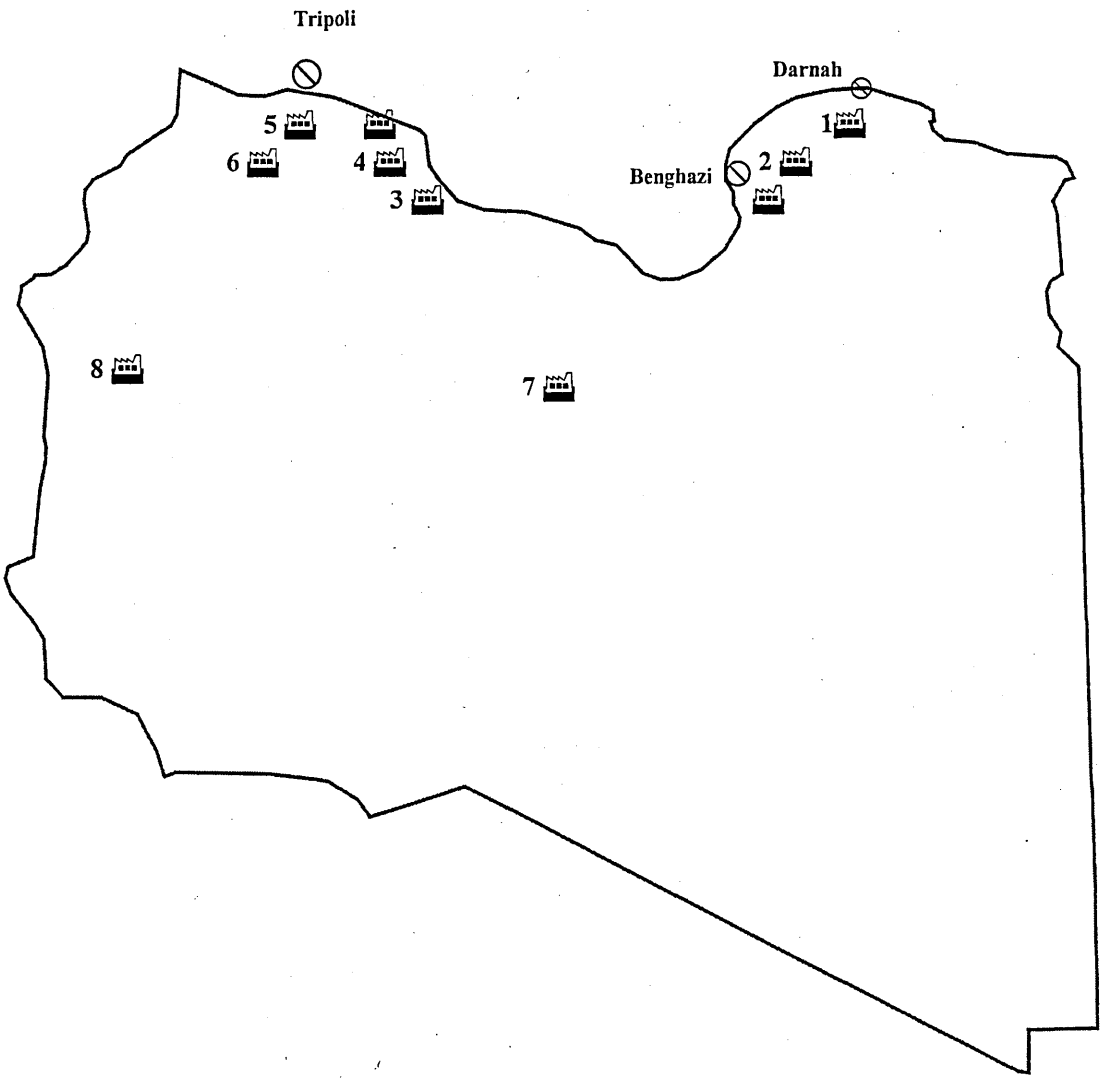
In Libya, abundant quantities of marine limestone and marl have been reported especially, in the northern half of the country, while the southern half of the country is yet to be explored in any form.

Among the other conventional raw materials, clay and ferruginous sandstone's are normally available at close proximity to the major limestone sources whereas iron ore will have to be procured from the only known single source (Wadi Shati). Bauxite is yet to be found in economic quantities. Lack of either flowing or ground water resource has necessitated adoption of only dry process cement manufacture. (Libyan Industrial Research Centre Report, 1983. Trans.)

The existing cement plants are using oil as the fuel and this trend will continue into the foreseeable future based upon national supply of this resource.

The situation with the cement raw materials within the country seems very positive with plenty of scope for optimal utilisation of the country's resources for the future.

Map No. (3) The locations of Libyan Cement Manufacturers:



1. Darnah Cement Plant
2. Benghazi Cement Plant No. 1
   Benghazi Cement Plant No. 2 (Al Hawwari)
3. Zliten Cement Plant
4. Al Khums Cement Plant No. 1
   Al Khums Cement Plant No. 2 (Libdah)
5. Al Swani Cement Plant
6. Souk el Khamis Cement Plant
7. Suknah (Al Jufarah) Cement Plant
8. Wadi Al Shati Cement Plant

3.3.4. The impact of quarrying on the environment

Quarrying has been practised over a very long period of time from the ancient civilisations (e.g Egyptians, Greeks and Romans) to the present day.
In all cases it has impacted upon the environment to a greater or lesser degree depending on scale of operation.

Modern quarrying include operations that have severe impacts on the environment. Quarrying is a huge industry worldwide employing tens of thousands of people and moving millions of tonnes of ore and rock per month. In the case of surface mining, the amount of overburden (material overlaying a mineral deposit that must be removed before mining), means that such actions have a major impact upon the land involved. These impacts may be temporary where the mining or quarrying company returns the rock and overburden to the pit from which they were extracted (This is part of the subject that this research addresses). (www.natural-resources.org.1999)

An actual quarry site or location is just the first step in a long line of activities before and after the digging and blasting starts. It is also at the centre of transportation routes (such as roads), energy infrastructure (power lines), processing plants. (Environmental Mining Council of British Columbia, 1997).

It is obvious that the visual impacts of relevant industrial activities (e.g. mining and quarrying) have not only been widely recognised, but nowadays are considered as some of the major environmental impacts. The aesthetic impact of the industrial activities on the environment (mining is one of the most characteristic of such activities) is difficult to reclaim subsequent to the operation ceasing (www.gnest.org, 1999).

Coppin and Bradshaw (1982, p. 2) state that quarries are generally accepted as open-cast excavations from which fairly massive and deep deposits of land or soft rock are extracted. This is usually for the production of aggregates. The excavations are fairly deep, and tend to work progressively outwards and downwards. For ease of working they are often on an escarpment or hillside, but they can be on hilltops or in flat land.

Aspects of impacts:

1- Visual intrusion "Blot on the landscape".

2- Dust impact on vegetation and people.

3- Noise impact on people and wildlife.

4- Impacts on transport and roads (noise, dust and vibration).

Each type of location requires a slightly different technique and working sequence. As blasting is the major activity in quarrying operations, Gunn, *et al* (1997, page 11) states that, all blasting has environmental impacts including, the ground vibration, air overpressure, and noise.

Murad, (1996, Trans.), states that, quarrying is an activity which can cause damage on one site, and be subject to restoration at another site at the same time. The term 'damage' means the damage, which can occur where the quarrying is located. This may cause disturbance of the landscape by creating an unacceptable and contrasting new landform. This applies especially to the vegetation cover, disturbance of wildlife often due to noise resulting from quarrying operations. There may be adverse effects on local residents.

The intention of restoration applied in another area, is to provide improvements in the environment along with the benefits, which will be gained from quarrying. The latter is in terms of excavation and ore extraction, which are used in developing other areas (such as building, opening new routes, bridges, dams, and steel industry *etc*). The intention is to offset damage by positive restoration and mitigation. This leads to the attempt to strike a balance between the economic demands and environmental quality.

Al-Haylah Environmental Association, 1989 Conference (Trans.), states that:
'Quarrying and Mining hazards and impacts are effective on all creatures which live in the surrounding area resulting from the consequences of each site's operations'.

As a result, the range of approaches to reclamation from non-intervention to large- scale earthmoving and re-vegetation schemes must be implemented to reclaim the exploited sites in terms of restoration and landform replication.

3.3.4.1. The history of limestone extraction and its impacts

From early Libyan history as presented in Chapter 3, Section 1, and through the history of Great Britain beginning with the Roman Empire (98-211 AD.), limestone extraction has occurred in both Libya and the UK. The excavation and the extraction methods and techniques at that time were similar in both countries.

Septimio Severo, the Roman who built the City of York in Great Britain, was born in the City of Leptis Magna in Libya. He is the person who caused the City of Leptis Magna to flourish by using the available limestone from the countryside surrounding the city. This is similar to how he did with the City of York and other Roman cities in Great Britain.

From the summary of regional history, the evaluation of the impacts of previous civilisations resulting from limestone and hard-rock quarrying, demonstrates the importance of the mineral to civilisation, and the often major impact of their extraction excavation and processing, on the landscape, vegetation, and wildlife. This runs from early history to present-day excavations.

3.3.4.2. Impacts of present-day quarrying

Pursuit of economic demands and the development of the technological tools, the quarrying industry has the advantage to follow-up the latest inventions in its domain. In the present-day, quarrying companies have the ability to overcome the hardest of rocks on the earth. The quarrying industry becomes more efficient than it was a hundred years ago, moreover, using the technology (such as ultrasound waves) in order to explore the underground buried mineral, has eased the ways of opening new minerals extraction sites.

As a result, the environmental damage, in terms of amenity loss, effects on wildlife, and the water environment associated with quarrying has increased. In accordance with the economic demands, solutions to decrease these severe impacts have been implemented in many ways under permissions and contract restraints.

Chapter 4. Planning Procedures

4.1. Introduction

The relevance of environmental impact assessment and environmental management systems to quarrying and associated industrial activities, is very often through the Planning Process. It is important therefore to set the scene and to note the similarities of the planning procedures in the UK and in Libya.

It is also important to be clear about the differences between these three areas of assessment and procedure. Whilst these vary in detail from country to country, and from region to region. They also reflect the particular economic and political system and historical context of each.

Essentially Environmental Impact Assessment (EIA) is a process applied to evaluate and hopefully mitigate adverse impacts of developments or industrial processes on the environmental resource. This may include aspects of economic and social impact too, and may be part of a bigger process. The EIA may be voluntary and part of an organisation's good practice or procedures, or it may be compulsory. The degree to which an EIA is mandatory will vary from Country to Country.

An environmental management system will often relate to an environmental audit (based on financial auditing models) and may include EIA as a part of its process. In essence the Audit and Management System provide a framework for good practice and good housekeeping in terms of the processes, procedures and monitoring of an organisation, a factory, an industrial process or other activity. The Audit includes assessments and monitoring with a review process designed to improve standards and to meet targets. Formal audits are accredited and meet stringent national and international criteria. Many commercial organisations in Europe and the USA now require bodies with whom they trade to have the necessary documentation in place to confirm compliance to an appropriate environmental management system. Furthermore, audits to be valid are usually undertaken or at least monitored by an approved external auditor.

In contrast to the above, the Planning Process is essentially a procedure that may vary from Country to Country or region to region, for the granting or with-holding of certain permissions for activities that require consent. As with some EIAs these are basically statutory tools. The planning processes applied in Libya and the UK are radically different and they reflect the contrasting histories of the two Countries and their people. They also reflect as this research will show the needs, issues and requirements of local communities and the different impacts of quarrying in the very different environments of North Africa and the north-western Atlantic environment of the UK. The function of the planning process and the procedures applied to both grant consent, and the requirement to restore (or to allow apropariate after-use) also reflects the contrasting issues of land-use, land area and population density in the two Countries.

The planning process may require a mandatory EIA before a decision is reached and might even specify the need for appropriate monitoring and environmental management systems once work is underway.

4.2. The procedures and requirements demanded by the Libyan government for the opening of a new quarry

The quarry developer (the investor) must obtain: -

1. Permits from the Electricity Company to confirm that, there are no underground cables or any future plans to extend the electricity network through the selected site.

2. Permits from the regional municipality to ascertain that, there are no plans to establish a new community on the selected site, also that there are no drainage or water pipelines planned to cross the site.

3. Permits from the Agriculture administration to declare that the nominated site is not appropriate for farming.

4. Permits from the Transportation administration to indicate whether there are any types of routes or motorways or railways planned to cross the selected site.
(The Libyan Mining & Quarrying Procedures, 1985) (See Figure 9.)

All the above permits are the premier conditions for permission. Policy No. 2 - 1972, states: The investor is required to undertake a commitment to ensure that they will be able to refill the holes if not required by the government, for a private purpose.

The investor is also required to replace suitable plantations, maintain and report about every artefact or ruin of heritage value, where they are found at the selected site, thereupon, the investor will be responsible for all the impact on the environment derived from the operations of exploitation, (such as blasting).

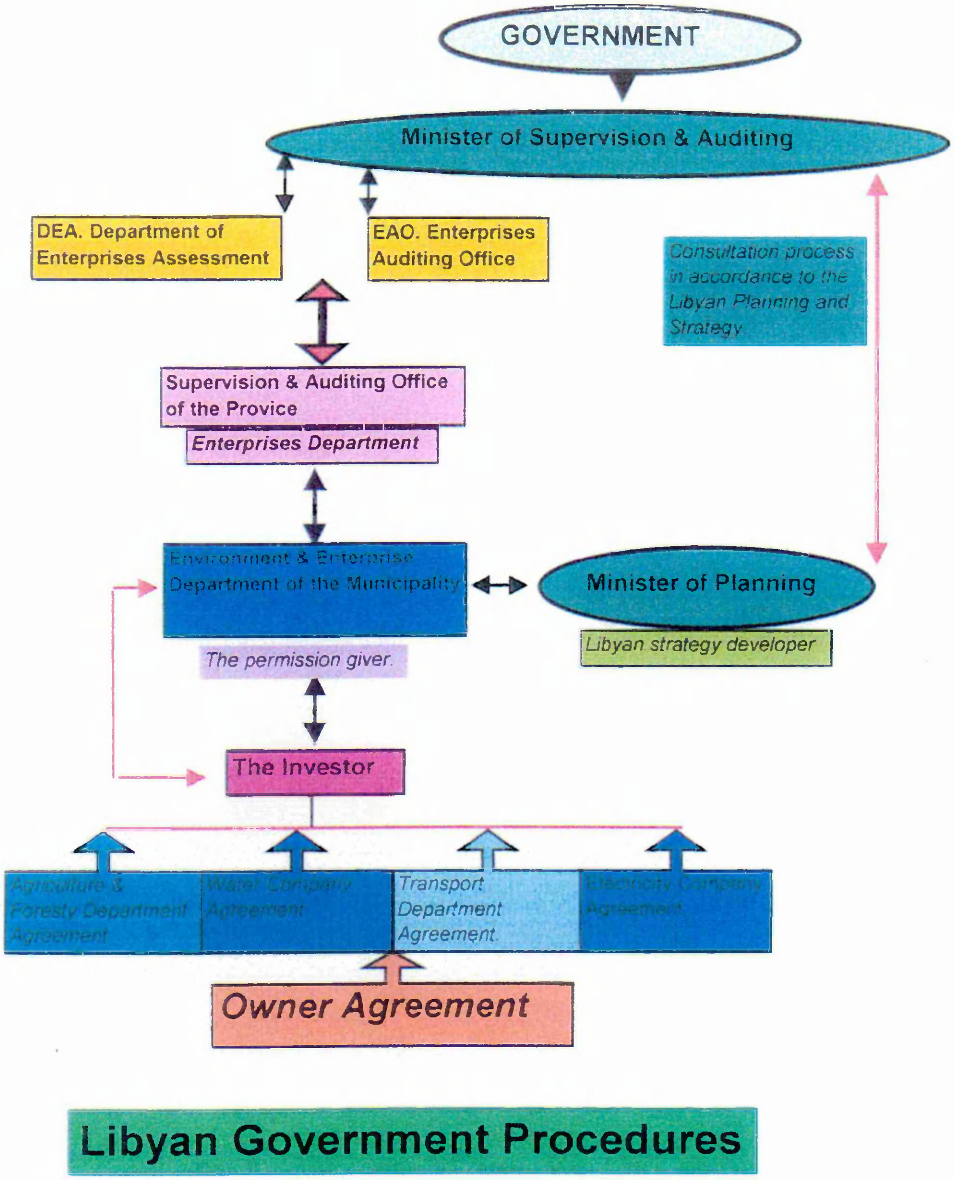


Figure 9. Relevant planning procedures of the Libyan Government

Copy of the official Libyan contract *pro forma* required in order to open a new quarry

The contract requirements of quarries investment

Libyan Arab Jamahiriyah

Ministry of Industry

Municipality of: ....

Enterprises and industrialisation overseeing office

Department of quarries and mines investment contracts and permits

1. Investor name: ....

2. The type of mineral: ....

3. The name of the site region: ....

4. The area of the quarry: ....

5. Annual rent (by Dinar): ....

(Payable to the Ministry of Industry)

6. Registration No.: ....Date: ....

7. The date of the contract beginning: ....

8. The term of the contract: ....

<u>Insurance</u>

1. Assurance of royalty (tax): ....Dinar.

Receipt No.: ....

2. Contract conditions: ....Dinar.

Receipt No.: ....

3. Operation conditions: .... Dinar.

Receipt No.: ....

The above requirements are prescribed according to article No. 49, Act No. 2, 1972 (Pertaining to the quarries and mines)

" <u>Quarries investment contract"</u>

Contract No. .... Quarry No. ....

Site location: .... Municipality branch: ....

Date: Day............ .Month........ . Year......... .

This contract is approved from five copies between all parties:

1. The Ministry of Industry representative. (The land owner)

Mr: .... **(1st party)**

2. The company representative. (Investor)

Mr: ....

Permanent address: ....

Identity No. .... **(2nd party)**

(Clauses of the contract see Appendix 1)

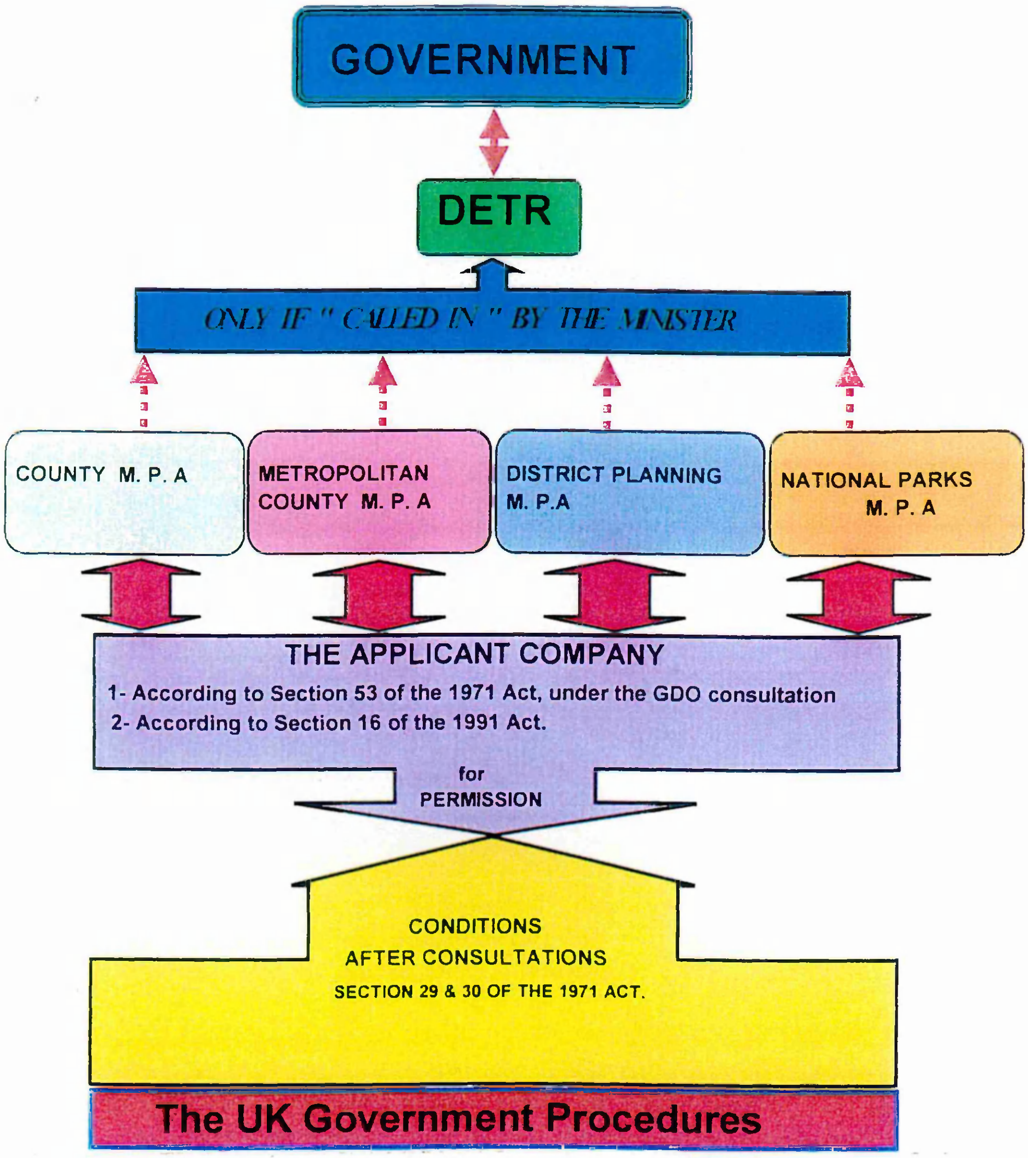
4.3. The procedures and requirements required by the UK Government in order to open or extend quarry

The UK was one of the first countries in the world to use modern machinery in quarrying. Indeed it could be argued that British professionals and experts are more knowledgeable than any others in the world in this kind of work. This especially is when integrated with the history of mining of which they are proud.
Extracting ideas, thoughts and methodologies from such people will clearly be beneficial for people from developing countries looking for better systems with which to manage their works both environmentally and commercially.
In the previous section, the relevant Libyan procedures and contract clauses were introduced and described. It is clear from the assessment that the Libyan contract procedure to open new sites clearly suffers from a lack of specific environmental conditions. In this aspect it is worth considering the process in the UK, along with the Environmental Impact Procedures. (These are considered in Chapter 5).
In contrast with the system in Libya, the process in the UK is essentially based around the following, (See Figure 10.):-

1- Strategic Planning and Resource Planning Context developed by government (National, Regional and Local), by employed officers with policy approved by elected, political members.

2- Proposals developed by individual minerals companies or quarry operators.
These are submitted to the local authority planning system whichever level is the 'Minerals Planning Authority'. These may then go through a Planning Application process and quite probably a Public Inquiry. The latter is chaired by an inspector appointed by the relevant Government Minister.

During the process there is full opportunity for other Government Agencies, Voluntary Conservation Bodies, Local Communities, and individuals to comment on the proposals. The officers for a Planning Application or for a Public Enquiry the inspector will make a recommendation to accept perhaps with conditions, or to reject. The final decision is political made by the elected members. There may also be various rights of appeal by the proposer if a decision is negative. The application may require an EIA from the applicant.



1. Planning Permissions under the Town and Country Planning Act 1971.
2. Planning and Compensation Act 1991.

Figure 10. Procedures required by the UK Government in order to open a quarry

The following sample from Derbyshire County Council is taken as an example of current practice in the UK for a contract to open or extend a quarry.

Copy of the UK Council's official contract *pro forma*
Required to open or extend quarry

DERBYSHIRE COUNCIL

TO I LINDLEY' ESTATES SURVEYOR
TARMAC ROADSTONE EASTERN
JOHN HADFIELD HOUSE' DALE ROAD,
MATLOCK, DERBYSHIRE

COUNTY OFFICES
MATLOCK
DERBYSHIRE

TOWN AND COUNTRY PLANNING ACT, 1971

Town and Country Planning General Development Order, 1977

In pursuance of the powers vested in the Derbyshire County **Council under the above Act and Orders, and with reference to your application (Office Code No.** BOL/888/414 **)**
submitted on the 11 August 19 88 **for permission** to extend existing limestone quarry, Bolsover Moor, Bolsover **in the manner described on the application and shown on the accompanying plan(s) and drawing(s) - NOTICE IS HEREBY GIVEN that permission for the proposed development is** GRANTED subject to compliance with the following conditions

Conditions:

1. This permission is subject to the condition that the development must be begun not later than the expiration of five years from the date of permission, unless some other specific period has been indicated in other conditions given.

For conditions (2) to (26) please see attached sheets.

Reasons for Conditions:

1. The condition is imposed in accordance with Sections 41,42 and 43 of the Town and Country Planning Act, 1971.

For other reasons for conditions see attached sheets

Date. ______________ **19**____ **Signed**________________.

(Conditions of the Contract see Appendix 1) (The UK's Mining Contracts, 1989)

Chapter 5. Environmental Impact Assessment

5.1. Introduction

Current thinking on international policies for environmental impact assessment and protection aims to preserve the ecological balance, to safeguard natural and human resources, to prevent and reduce the various forms of pollution, and reconcile the requirements of development with the needs of the environment. The methodologies and approaches developed should protect the environment or the natural resource likely to be affected by a proposed project. This includes air, water, soil, population, fauna, flora, climatic factors, and material assets, (including the architectural and archaeological heritage, landscape and the interrelationship between the above factors). Along with this is the intention to at least protect, and hopefully improve, the living conditions of people affected.

All these approaches are drawn together by a wide range of international and national strategies and legislation to promote environmental improvement. Today this is often implemented through the utilisation of environmental impact assessment (EIA), and is generally in the context of movement towards sustainable development, in accordance with the principles of the 1992 Rio Conference (Brundtland (Ed.), 1987).

Technological progress frequently has severe impacts on environmental resources and quality, and modern life styles and demands come at an expensive price. Indeed in many cases, the price is one, which we are only just starting to realise and pay. This includes the huge environmental damage, which has occurred from industrial projects, directly and indirectly. These include the consequences of industrial activities (such as mining, quarrying and cement manufacture) along with military operations, and 'research' (such as nuclear testing), and some 'natural' disasters such as floods and drought.

Without adequate resources people wait to see what nature inflicts upon them, and can only respond in limited ways. They are without any really strong actions or interventions to reduce or prevent the current or forthcoming disasters. To moderate the adverse environmental impacts, we must both develop means of avoidance and mitigation of damage, and legislate for procedures to decrease the impacts of technological progress. The consequences of failure are industrial and environmental crises, and their consequence impacts on both human life and the natural environment.

The process of Environmental Impact Assessment (EIA) is one way of attempting to reduce the adverse effects or the impacts, which arise from the technological progress.

The EIA has been defined below by a number of authors, e.g. Wood (1995), Canter (1977,1996), Weston (1997), Wathern (1992), Glasson *et al.* (1994), Jorissen and Coenen (1992), and Munn (1979). This approach is now being considered in terms of the relevant activities of particular countries and organisations. Gilpin (1995) provides a broad overviews of the international approaches and issues, and this relates to the broad spectrum of international environmental policy (for example see Sloep and Blowers (Eds.) 1996) and specifically to matters of global environmental change (See Graves, 1986). However, in many cases, the social, economic and environmental issues relating to emerging economies around the world are given relatively scant treatment. Barrow (1997) and Lee and George (Eds.) (2000) Provides useful first insights into case studies with increasing relevance to North Africa and to Libya specifically. However, there appears to be no literature derived from actual Libyan case studies, and indeed, environmental management practice in Libya itself, is very limited.

5.2. Definitions

Environmental impact assessment (EIA) refers to the evaluation of the effects likely to arise from a major project (or other action) significantly affecting the natural and anthropogenic environment. (Wood, 1995).

Canter, (1977 & 1996) defined the EIA as the systematic identification and evaluation of potential impacts (effects) of proposed projects, plans, programmes, or legislative actions relative to the physical - chemical, biological, cultural, and socio-economic component of the total environment.

EIA is also defined as a process for identifying the likely consequences of activities for the biogeophysical environment and for human health and welfare. This is to address particular activities and also as a means of collating relevant information, at a stage when it can materially affect the decisions of those responsible for sanctioning development proposals (Weston, 1997).

Wathern (1992) however, also puts it more succinctly: EIA is a process having the ultimate objective of providing decision-makers with an indication of the likely consequences of their actions. Glasson *et al.* (1994) argue that EIA is a systematic process for the examination of environmental impacts of development and the emphasis, compared with many other mechanisms for environmental protection, is on prevention. Indeed, the EIA described by Jorissen and Coenen (1992) as an instrument of preventative environmental management.

This underlying purpose is important for an understanding of the whole process. It requires that EIA take place at a much earlier stage of project development than in traditional planning or development control assessment (Weston, 1997).

Furthermore, Weston (1997) notes that Selman (1992) emphasises this by arguing that EIA should ideally ensure that thorough examination of a proposal takes place at the earliest possible opportunity. This should preferably coincide with the earliest stages of project planning. Design and performance standards can then be influenced from the outset. Wathern (1992) goes further. He suggests that the greatest contribution of EIA to environmental management may well be in reducing adverse impact before proposals come through to the authorisation phase.

Additionally, Munn (1979) states that " *To identify and predict the impact on the environment and on man's health and well being of legislative procedures, and to interpret and communicate information about the impacts*".

The former UK DoE (Department for Environment) (1989), (which became the DETR), defined the EIA as "*The term 'environmental assessment' describes a technique and a process by which information about the environmental effects of a project is collected, both by the developer and from other sources, and taken into account by the planning authority in forming their judgements on whether the development should go ahead.*"

EIA is considered to be a technical exercise, the object of which is to provide decision-makers and the public with an account of the implications of proposed courses of action before a decision, is taken.

The above definitions provide a broad indication of the objectives of EIA, and illustrate differing concepts of EIA. Finally, they emphasise the role of EIA in informing the decision-making process for example, the UN Economic Commission for Europe (UNECE) in (1991), declared that the EIA is "*An assessment on whether the development should go ahead*". (www.unece.org)

5.3. A short historical review of Environmental Impact Assessment as an international process

5.3.1. Historical summaries

The EIA process has been developing since the 1960s when it was first given formalised status through the USA's NEPA (*National Environmental Policy Act*, 1969, USA). This required EIA for federally funded or supported projects, which were likely to have environmental effects, (Weston 1997). Yet as Fortlage (1990) argues, environmental assessment has been with us for much longer.

The NEPA (*National Environmental Policy Act*) used EIA as a policy implementation measure rather than simply a planning technique. The introduction of EIA was part of a whole redirection of the planning process, other wise, the NEPA established policy principles for the enhancement, of the environment, which EIA would implement. (Weston, 1997).

5.3.2. Environmental Impact Assessment in the UK

From the late 1940s the United Kingdom had a well developed, if somewhat *ad hoc* in application, land use planning system and used public inquiries, often chaired by a judge, to fulfil a proposal similar to that of EIA. (The USA, before the NEPA, had nothing like this system. (Wood, 1995).

The UK Government introduced the EIA within an existing complex and legalistic planning system. However, the UK Government had been opposed to the formalised introduction of EIA. There were a number of reasons for this. Firstly, they took the view that the UK's Development Control System was already carrying out the function of environmental assessment. Secondly they saw EIA as a further impediment to industrial development. Thirdly they dislike having new regulations imposed from outside (Weston, 1997).

The UK authorities have used a different terminology to that generally adopted elsewhere. For example, 'environmental assessment' is used in place of 'environmental impact assessment' and 'environmental statement' instead of 'environmental impact statement'.

5.3.3. Environmental Impact Assessment in Asia

In recent decades, Asia has been experiencing faster economic growth than any other region of the World. It also has many of the World's poorest people. Poverty often forces people to over-exploit natural resources, leading to degradation of the very forest, soil, and water upon which they depend. This perpetuates their poverty. Economic growth may alleviate poverty and lead to a higher quality of life. If properly planned, it may also reduce pressure on the environment and stem environmental degradation. However, unregulated and unplanned economic growth can have the opposite effects. Pressure on the environment may be increased, environmental degradation may occur at greater rates, and the sustainability of ecological and economic system may be compromised (Jalal, 1993).

Lohani (1997) states that, the desire of sustainable development, is the result of carefully integrating environmental, economic, and social needs to achieve both an increase of living standards in the short-term, and a net gain or equilibrium among human, natural, and economic resources to support future generations. This is relevant to issues of dealing with the environmental problems of Asia, as well as the promotion of sustainable development.

Also they state that, to meet the development challenge for Asia - poverty alleviation through environmentally sound development, then a number of very significant and constraining problems must be overcome. These problems include land degradation and depletion of natural resources; human settlements unfit for living due to inadequate shelter, sanitation, and water supplies; soil, water, and air pollution; and global issues like global warming, ozone depletion, and loss of biodiversity. Population pressures, lacks of development and the development process itself, are all contributors to the existing environmental situation.

EIA and development planning in Asia has an important role to play in resolving these environmental problems through its ability to contribute to environmentally sound and sustainable development. Developing countries in Asia have recognised the importance of incorporating the EIA process into development planning. Development planning takes place at a number of different scales, and environmental concerns need to be considered at each one.

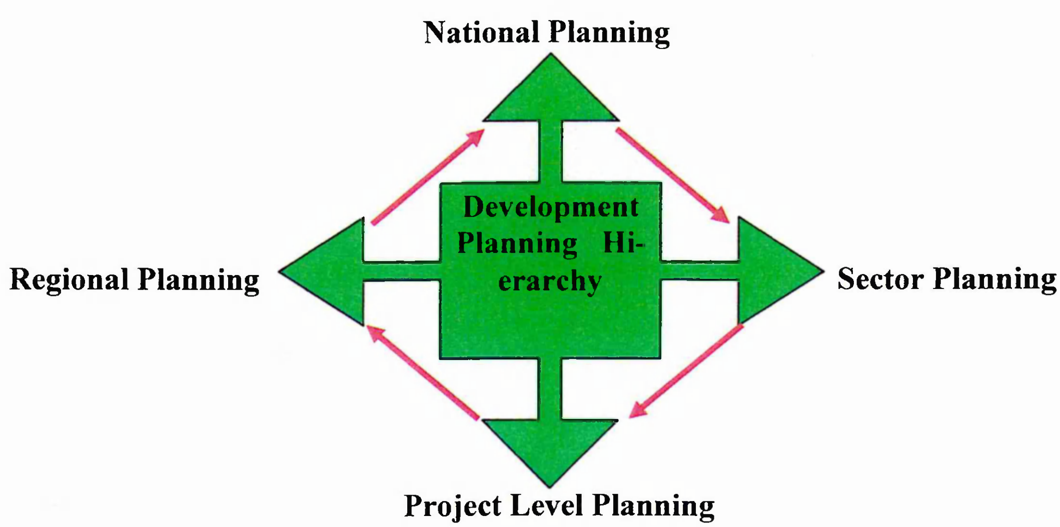


Figure 10 a. ***Development planning hierarchy (source: adapted from Asia Development Bank, 1993), and the following table is the integration of environmental planning***

Table 3. Guidelines of integration of environmental planning

Level	Integration of Environmental policies and procedures.	EAP or Management / Technical used.
National	*Environmental policy included in national action plan.*	• *Environmental profiles.* • *International Assistance Agency Country Programming.*
Regional	*Economic, environmental development*	• *Integrated regional development planning.* • *Land use planning.* • *Environmental Master Plans.*
Sectoral	*Sectoral review linked with other economic sectors.*	• *Sector environmental guidelines.* • *Sector review strategy.*
Project	*Environmental review of project activities. EIA procedures.*	• *EIA.* • *Environmental guidelines.*

5.3.4. Environmental Impact Assessment in the USA

As noted earlier, the history of the environmental control in the United States is remarkably brief, but typically vigorous. Prior to 1970, there was no effective Federal control over land use. Whilst much state and local control over the use of land is not much stronger now compared to the present in the United States. At Federal level there is now an imposing array or system of detailed and complex controls over air pollution, water pollution, hazard wastes, and land degradation, *etc.* (Wood, 1989). Wood (1995) has stated that, the United States National Environmental Policy Act, 1979, (NEPA) provides:

*"**Sec. 101.** (a) The Congress, recognised the profound impact of man's (human) activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanisation, industrial expansion, resource exploitation, and new and expanding technological advances and recognising further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man (human), declares that it is the continuing policy of the Federal Government, in co-operation with State and local governments, and other concerned public and private organisations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man (human) and nature can exist in productive harmony, and fulfil the social, economic, and other requirements of present and future generation of Americans.*

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of Federal Government to use all practicable means, ... to the end that the Nation may:
(1) Fulfil the responsibilities of each generation as trustee of the environment for succeeding generations;....."

*"**Sec. 102.** The Congress authorises and directs that, to the fullest extent possible:*
(1) The policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and
(2) All agencies of Federal Government shall...

(c) Include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on:

(1) The environmental impact of the proposed action,
(2) Any adverse environmental effects which cannot be avoided should the Proposal be implemented,
(3) Alternatives to the proposed action,
(4) The relationship between local short-term uses of man's (human) environment and the maintenance and enhancement of long-term productivity, and
(5) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

However, prediction of the environmental consequences of proposed development projects (or policies, plans, or programmes) is both technically demanding and fraught with uncertainty. Such predictions can be organised into near-term (1-5 years), Intermediate (6-10 years), and future (>10 years) categories, with uncertainty increasing with the more distant time frames. These same dilemmas are associated with "predicting" the future of the EIA process within any country (Canter, 2000).

Canter (2000) suggests that, the following four themes may characterise the EIA process in the United States in the coming decade; (1) usage of the World Wide Web; (2) continued introduction of new topical and policy themes into the process; (3) greater emphasis on implementation of mitigation measures; and (4) recognition that numerous permit applications represent "targeted" impact studies. Greater confidence in these predictions are associated with the first several years of the decade, therefore, a continuing trend during the coming decade is expected to be associated with new topical and policy themes being introduced into the EIA process. In addition, application of the EIA process to the life cycle analysis of manufactured products, as well as the construction, operation, and decommissioning phases of projects, is also expected to receive greater emphasis.

In summary, the EIA process in the United States has matured considerably since its initiation in 1970. However, it is still dynamic as suggested by the above "predictions" for the coming decade. This evolving nature of the process represents a continuing challenge to EIA professionals and organisations in the United States.

5.3.5. Environmental Impact Assessment in Africa

Most African Countries are considered as 'developing countries'. Due to the state of their economies and both social and political structures, the EIA processes in these countries are poorly implemented. This often relates to the lack of, or debility of, the decision-makers and because of politically unstable situations. For these reasons and others, the EIA process in the whole of Africa might take a long time to be accepted. Even if accepted, it will take a long time to approach the same level as that in the western world. Ofori (1991) in Gilpin (1995) state that, "*Although the use of impact is spreading, Africa generally lags behind in the adoption of environmental impact analysis. South Africa, Egypt (considered earlier, with Mediterranean states), Nigeria and Ghana have made most progress with environmental impact assessment.*" In Africa, when used, impact assessment has often started after project implementation and has tended to be treated as a 'stand-alone tool'. It has therefore often been of limited value (Kamukala & Crafter, 1992).

There has been interest in environmental impact assessment in South Africa since 1970s with mandatory requirements since the early 1980s. Sowman, (1995) reviewed the development of environmental evaluation in that country and reported on its attempts to establish integrated environmental management. Several other countries have introduced EIA legislation or procedures, but generally these are still at an early stage of implementation. In Tanzania for example, the Government has met some of the difficulties of introducing a national system by developing EIA procedures of its own (www.cleiaa.org.2000, 2001)

5.3.6. EIA in North Africa

With the exception of **Egypt**, the EIA in North Africa has been introduced and accepted only recently. Recent developments have resulted from Southern European Countries' successive demands for environmental procedures. This is particularly through the agreement at conferences between the North Africa and the Southern European countries.

Tunisia for example has a detailed EIA system enacted by presidential decree, with discretionary provisions relating to its implementation. These have mainly been applied for depending upon which EIA was required by local and international organisations (www. tunisiaonline, 2000).

Tunisia's policy of environmental protection aims at preserving and reducing the various forms of pollution, and reconciling the requirements of development with the imperatives of the environment, in order to protect the natural elements such as (air, water, soil, and biodiversity). Improve the living condition of the populations, and attenuate the risks threatening these resources. All these actions are part of the national strategy for sustainable development, and in accordance with the principles of the 1992 Rio Conference. (www.tunisiaonline, 2000)

As a part of the Tunisian Government's efforts to safeguard an acceptable environment for the country and for future generations, the Ministry of the Environment and Land Use Management was established in October 1991. This was to complete the institutional system responsible for the environment and natural resources, improvement of living conditions, and land use management, and for seeing that such policy is implemented. It is also responsible for promoting legislation in the areas of environmental protection, nature conservation, and land use management. In accordance with the principles of the 1992 Rio Conference and its recommendations, Tunisia has stepped up its bilateral and multilateral co-operation in the field of the environment (www.arabnet, 2000. Trans.)

As already noted, Egypt has made more progress with impact assessment than most African countries. Most assessments have been carried out by development agencies involved in large projects. Since the 1980s the Egyptian Government has been training impact assessors, and an Egyptian Environmental Affairs Agency has been established. Egypt has provisions for compelling or forcing developers to deposit an indemnifying bond to pay for any adverse impacts their activities cause at or for some years after completion; however, the requirement to pay can be waived on some projects (Barrow, 1997).

Educationally, Egypt through its Universities has established a number of Environmental Institutions and Centres to provide umbrella organisations for interdisciplinary environmental research and education, including such fields as environmental technology, Biotechnology, Environmental Science, Environmental Policy, and Environmental Economics. These programmes will be pursued in areas of research and development that are relevant to the current needs and priorities of EIA in Egypt. (www.arabnet. 2000, Trans.)

The Egyptian Government by setting up programmes to increase environmental awareness in the curricula of the primary and secondary schools (public and private) throughout Egypt. Moreover, the Egyptian Government for EIA will interact with industry, consulting firms, and Government agencies and will host and establish an information centre to provide the community with a resource for environmental issues and programs, with reference to EIA requirements and procedures (www.egyptonline, 2000).

The (DRTPC) which is Development Research and Technological Planning Centre at Cairo University (CU) summarises its policy which is supported by the Egyptian Government, in four areas covering the basic activities of DRTPC: -

1. Support of planning activities of state institutions and participation in policy definition.
2. Provision of integrated consultation services for governmental organisations as well as public and private sector companies.
3. Transfer of technology developed through applied research to industry.
4. Provision of continuing education programmes.

This includes:

- The design and implementation of large efficiency projects,
- technical support to industrial facilities and feasibility studies,
- environmental audit for industrial plans,
- energy and environmental management's in tourism industry,
- environmental impact assessment of large industrial projects,
- environmental and compliance action plans,
- measurements, monitoring, and environmental register, and design and implementation of pollution reduction (www.egyptnet, 1999).

The Ministry of Environment, and the IEST (Institute for Environmental Science and Technology), will strive to achieve ecological sustainable development in Egypt, development within the carrying capacity of the environment to meet the need of the present without compromising the ability of future generations to meet their needs. The traditional measures of growth are based on increases in industrial output, finding the most immediately profitable use of resources such as land, water, air, and other new materials, and shifting responsibility for the degradation of the environment away from the developer and onto the public or future generations.

Sharif, (1992) argues that these can not, in the long run, serve as appropriate measures of increased value. Thus, sustainability redefines the concept of economic growth, economic development, and economic wealth away from the short-term gain of a powerful minority and towards the long-term benefit of entire communities. (www.arabnet, 2000. Trans.)

In addition, sustainable development and EIA rests on the premise that it is necessary to preserve and replenish rather than deplete the resource base, which support humans, plants, and animal life. (www.egyptonline.2000)

Morocco is the foremost phosphate producer in the world, and in general has large deposits of raw materials, required across the world. EIA procedures and obligations are therefore necessary to decrease the environmental impact in areas where extraction operations are located. (www.moroccoonline.com)

Morocco is in the process of developing a national environmental strategy to make its parks and ecological reserves more user-friendly and accessible. This is in part economic investment and tourism to generate greater revenue. It is intended that this will support the implementation of the EIA procedures and consequential requirements. In collaboration with local park officials, and the Government, volunteers are developing environmental management strategies, which address the particular ecosystems of the individual parks. They have promoted ecotourism development through the creation of leaflets, regional mapping, and species inventories; designed environmental education curricula; and introduced solar ovens to nearby communities to reduce wood consumption in these environmentally fragile areas. (www.arabnet. 2000. Trans.)

Algeria is the biggest country in North Africa; its main industrial products are Oil, Gas, Cement, Steel, and Gypsum. Since being awarded its independence, Algeria has started to build up its own infrastructure by investing the Oil and Gas revenue in establishing manufacturing, highways, power stations, farms, *etc.* As a result of these activities, environmental issues and risks have started to appear, and the environmental impacts have continued to expand from one sector to another through the developing process. (www.arabnet.2000. Trans).

The EIA regulations and the national environmental strategy in Algeria are in progress to make the environment more accepted, and to help the humans and the ecosystem to recover from the economic impacts speedily.

Over the last few years, in Algeria, increasing attention has been given to the concept of environmental impact assessment to deal with current environmental issues, (such as soil erosion from overgrazing and other poor farming practices; desertification; dumping of raw sewage, petroleum refining wastes and other industrial effluents are leading to the pollution of rivers and coastal waters; the Mediterranean Sea, in particular, is becoming polluted from oil wastes, soil erosion, and fertiliser runoff, leading to an inadequate supplies of potable water via desalination. (www.algeriaonline.2000. Trans).

In this context, Algeria has signed environmental international agreements (such as Biodiversity Protection, Climate Change, Desertification, Endangered Species, Environmental Modification, and Law of the Sea, and Nuclear Test Ban *signed but not ratified* (www.odci.gov/cia/publications, 2000).

Libya during the 1990s has shown no real improvement in its EIA regulations and procedures. This is to some extent because of it being subject to the UN sanctions in relation to the Lockerbie Issue. In spite of these problems, the Libyan Government has made modest attempts to encourage the Libyan people and voluntary groups to establish domestic organisations to deal with the environmental issues. This is under the Libyan Government Supervision Organisation, which is called The Environmental Common Institution (ECI). (www.arabnet.2000. Trans).

Before the UN economic sanctions, the EIA procedures in Libya were somewhat varied, and the application of EIA regulations were concentrated on the Oil Companies' project sites. Almost all these operations were western companies, (such as American, British, German, Italian, French, *etc.*), and this led to the EIA procedures currently utilised in Libya, being introduced by Western Oil Companies working in Libya since 1959. (www.libyaonline.1999. Trans).

In 1985, the Libyan Bright Star University was established close to Al-Bregah the biggest oil industrial city in Africa. This was to provide a generation of Libyan people educated as experts in oil production, and in related environment protection. However, this training is specific to the Oil Industry, and perhaps not directly relevant to other fields (www.libyaourhome.1999. Trans). With the exception of the Oil fields areas, many regions and activities in Libya are lacking in environmental procedures, environmental protection, and sustainable development. On the other hand, the majority of the Libyans have no idea about the environmental risks and the causes of these risks or even what the word 'Environment' means. This is largely because all these ideas and concepts relating to environmental issues were neglected following the UN sanctions. The rest of the World carried on dealing and treating environmental problems step by step in accordance with the 1992 Rio World Summit regulations and instructions, which Libya did not attend. Since the sanctions were suspended in 1999, the Libyan Government has effectively engaged in a race against time to gather ideas, guidance or programmes to help in relation to environmental protection, EIA and its regulations.

This addresses matters of environmental health to improve the living conditions of the people. Focus has been on the health of the people, appearance of the cities, the countryside situation, wildlife protection, green house gases reduction, water consumption guidance, irrigation rationalisation, waste disposal and dumping, *etc.*

With regard to land restoration and reclamation in Libya, the UN sanction may be a key factor, which has prevented ideas and technologies being accessed by Libyan industry. As a result, the restoration and reclamation procedures and commissions in Libya have been largely neglected from 1990. Since then much of the reclamation equipment necessary and techniques previously not available have started to influence the Libyan system. In spite of this these approaches are mostly limited to the oil fields companies and associates. The UN sanctions were implemented faster than the country had sought and therefore preparations were limited.

The current process of restoration and reclamation of quarries is progressing but is limited particularly in the private sector (such as dimension stone quarries), in accordance with the official contract clauses. However, with the large projects like limestone and clay extraction quarries for cement manufacture the actions expected as a part of EIA procedures, are apparently absent. The exceptions to this are relatively modest conservation practices such as planting trees to prevent soil erosion on the slopes around the quarry.

Due largely to economic factors (depression) the government conventionally overlooks many former cement quarries, when restoration is considered. Environmental and amenity considerations are frequently neglected. The Libyan Government and its industrial and economic organisations have never effectively taken the full assessment of former quarries and derelict land into account. However, transferable ideas regarding improvement to derelict land and re-use of former limestone quarries have reached the Libyan Government from the UK, and elsewhere. Information gained from research and long-term experiments have provided a considerable body of knowledge and techniques applicable to land improvement, restoration and reclamation. As a consequence new institutions and environmental departments at two Libyan Universities have been opened under Libyan Research Centre supervision, to collect all obtainable environmental information from the rest of the World and pass it on to the local Universities, Research Centres, and Domestic Environmental Organisations.

Chapter 6. The Reclamation of Former Quarries

6.1. Introduction

In addressing the issues of quarry impact on the environment and on local people it is necessary to consider not only how adverse impacts can be avoided or mitigated against, but also how used sites can be restored to positive use. Such restoration in both Libya and the UK will normally be 'conditioned' when consent for quarry working is given.

Restoration may lead to the use of a site for agriculture or amenity and conservation. it may involve the re-forming of land contours and the re-vegetation of either all of the worked land or selected areas. It may include the 'naturalisation' of former extraction surfaces - rock faces *etc* by means of positive restoration tools such as restoration blasting. Restoration will generally involve the site being brought back to a condition of little adverse landscape impact or even positive impact , and perhaps a positive impact on wildlife *etc.* Once again the cultural and historical context of the industry and the site will influence the interpretation of exactly what is meant here.

Reclamation can be the re-use and making available for future land utilisation. This will involve the removal of any contamination, the making safe of dangerous structures and the bringing of the site into a condition fit for a future use.

Finally, after reclamation and / or restoration there is the after-use of the site and the location. This is clearly influenced by the factors described above. The need for restoration and reclamation , will be influenced by the potential after-use. Likewise the possible after-use will be determined by the condition of the site and the extent of reclamation and of restoration.

Bradshaw and Chadwick (1980, p.1), state that " Land is one of our most real assets and one of our major natural resources". People of both present and past civilisations have had a considerable knowledge of the importance and the value of land and of its vulnerability. However, their desire to improve their life style has often overcome their long-term care for the well being of the land.

The word land and the environment mean everything on earth in relation to the rocks, soils, life forms including people, the water covering the land and the atmosphere that surrounds it. However, since humans evolved to dominate the land, and to exploit and explore the benefits of the land's resources, people have been exploiting the resources in unsustainable ways and often without due consideration. Very often they have not made any effort for future provisions or expectations for site management or restoration after-use. This human behaviour has led to the contamination of former fertile lands, of the seas, the rivers, the atmosphere, and even the people. This behaviour has often developed in a situation where natural resources are easily available, and the human population is relatively low. The impacts of activities (including the disposal of waste and the legacy of dereliction) on the environmental resource are relatively low and easily absorbed into the environment, or they are of limited and local extent only. However, as human populations increase, and as their demands become more intensive and more sophisticated, then the impacts and their effects become more acute.

This present research project focuses on the problems that result from the extraction of raw materials for cement and its impacts, on both the social life of the adjacent communities, and on the amenity and the appearance of the landscape where the operations are located. Furthermore, it addresses the impacts on the ecology of the sites, the effects on the wildlife of the surroundings areas resulting from mineral workings and their economically led demands. Much of the exploitation has proceeded without any consideration of the consequential impact upon the environment. Finally, the research considers the appropriate solutions or techniques to rehabilitate the land to an appropriate after-use, and to reverse the effects of the destruction that people have caused in order to improve for economic gain, in prospect of improved their quality of life.

6.2. Definitions:

Damaged land: the term 'damaged land' is used to cover both derelict land and that associated with old minerals workings (Land Use Consultant & Wardell Armstrong, 1996).

Derelict land is the land which is in poor condition because of neglect, or that land which has been abandoned or deserted (www.microsoftencyclopedia.com, 2000).

Moffat and McNeill (1994) state that, derelict land is a large area of land that is being worked for minerals, and for surface mineral extraction.

Contaminated land: contaminated land has not been officially defined in the UK. However, one definition produced by an international working group (the NATO Committee on Challenges to Modern Society CCMS) provides a useful definition of contaminated land "*Land that contains substances which, when present in sufficient quantities or concentration, are likely to cause harm, directly or indirectly, to human, to the environment, or on occasion to other targets.*" (Harris and Herbert, 1995)

The word quarrying is an action in an open or surface area identified as a quarry, for the excavation of rock used for various purposes, including construction, ornamentation, cement making, and road building. The methods of quarrying depend on the desired shape of the stone and its physical characteristics. Sometimes the rock is shattered by use of explosives (e.g. for roadstone). For building stones, a process called broaching, or channelling is used, whereby holes are drilled and wedges inserted and hammered until the stone splits off. This method was probably used by the ancient Egyptians, the Romans, the Greeks, and the Incas (www.microsoftencyclopaedia.com, 2000).

* Mining is the process or business of removing minerals from the earth.
* Mine is an excavated area from which minerals, often in the form of ore, are extracted, or an area within or on the surface of the earth where there is a deposit of ore, minerals, or precious stones.

6.3. Quarry Restoration Procedures

Restoration plans vary from one site to another. A number of factors should be taken into account to ensure the best restoration management with a satisfactory end-product.

Coppin and Bradshaw, (1982), summarise the restoration procedures into the following six points:

1. **Analysis and evaluation of site and soils**
2. **Landform**
3. **Soil preparation**
4. **Plant species selections**
5. **Methods of vegetation establishment**
6. **Management and After-care of Restored Land**

Each procedure of this list has its own protocol steps in restoration activities. Coppin and Bradshaw, (1982) give the main points of restoration procedure as follows:

6.3.1. Analysis and evaluation of site and soils:

The key methodologies relate to the following:

1. ***Survey and sampling techniques:*** methods for sampling surface soils and deeper strata, sampling patterns and density, on site test and descriptions, sample preparation for storage and analysis

2. ***Physical analysis:*** for particle size, density, moisture retention characteristics, and rock slaking.

3. ***Chemical analysis:*** soil pH, lime requirements, potential acidity, plant-available nutrients and their extraction, exchange capacity, total nutrients in soil, determination of nutrients in solution, electrical conductivity.

4. ***Plant material analysis:*** this has many limitations as a diagnostic tool, but it can be useful if sample collection procedures are standardised. The collection and treatment of plant materials for analysis may be a part of the procedure.

5. ***Bioassay and growth trials:*** these can be complementary to soil analysis, especially when dealing with unknown materials. Pot and field trials, treatments and layouts, growth assessment may be required.

6. ***Vegetation survey:*** the description and assessment of vegetation as both a baseline before operations and monitoring of reclaimed areas to follow progress and composition of plant communities. Sampling methods and description of vegetation; certain species of plants can be indicative of soil conditions.

6.3.2. Landforms

This relates to the aspects of landform that affect vegetation establishment and after-use. These are:

1. ***Overburdens*** and wastes are a major component of the landform, and will need eventually to be vegetated. It is important, therefore, to consider the soil potential of tipped materials before tipping, so the most favourable can be placed on the surface.

2. ***Tips and embankment:*** It is important to integrate these with the landscape to minimise the visual intrusion. There may be some scope for siting embankments where they will screen plant or workings, though sympathetic shaping and re-vegetating will be necessary to avoid them becoming a greater eyesore than the feature they conceal. Methods of tipping and restoration, or perimeter tipping should be adopted where possible. Design and treatment of silt lagoons must be undertaken with their stability requirements fully in mind.

3. ***Drainage and erosion control:*** Some guidance is given on the drainage requirements and installation for tips and slopes. There are essentially two types: fairly intensive but short-lived structures designed to prevent sheet and gully erosion by surface water runoff, and a permanent subsurface water drainage system installed after 2-5 years when the site has become well established and settled.

4. ***Pits and quarry excavation:*** Like tips, the visual intrusion of excavations can often be reduced by careful design of working methods, within the constraints of geology and production requirements. There are many different ways of treating wet excavations, quarry faces pit and quarry floors and benches.

5. ***Landfill and waste disposal:*** the selection of suitable old pits and quarries as sites for disposal of domestic and industrial waste is very complex and there are many criteria for selection and filling. Once filled and settled, they can be restored in much the same way as other quarries.

6.3.3. Soil Preparation

This is relevant to the practicality of site preparation. In particular it can help overcome the various problems of establishing and growing plants in quarry situations. Many of them can be incorporated as a normal part of quarry operations. The main aspects relate to:

1. ***Soil movements:*** Careful handling and treatment of soil materials can greatly reduce the amount of remedial work required later on. Large earth moving machinery can cause considerable damage to soils (both topsoil and other selected soil materials) when stripping and re-spreading.

2. ***Ripping and sub-soiling:*** can restore some of the quality of soil damaged by compaction during handling and spreading. It improves soil aeration and water infiltration, and thus root development.

3. ***Bulk organic*** or inorganic amendments can be applied to the soil or spoil surface to improve conditions for plant growth. These include topsoil, suitable over-burdens or wastes, manure, sewage sludge, wood-wastes and peat.

4. ***Fertilisers*** are a cheap and convenient way of providing essential plant nutrients; soluble quick acting as well as slow release materials are available. However, it is not satisfactory to rely on continual inputs of fertilisers, as this becomes expensive.
A careful fertilising plan should encourage the build up of a self-sustaining soil-plant system where natural cycling supplies all the needs.

5. ***Surface and seedbed*** preparation is important for the successful establishment of plants from seed. A coarse, friable surface will receive broadcast seed well, reduce surface water run-off and increase infiltration. A good soil-seed contact will mean better seed germination and establishment.

6.3.4. Plant Species Selection

Selecting the right plant species for a particular combination of site conditions and after use is a job for a specialist. Clearly the suitability of species will vary greatly over the world due to climatic differences:

1. The main selection criteria involve considerations of after use, climate, soil and role required of the plants, whether primary colonisers, soil builders or climax communities.

2. Plants possessing a wide variety of habits and growth forms are available, often with local modifications. These local forms are called ecotypes, and this variation has been exploited in plant breeding to produce cultivated varieties. It is important to select the correct ecotypes suited to the site, as there is much variation in tolerance of soil or climate within a species.

3. It is important to provide a balanced and ecologically sound species mixture for every site. This applies to trees and ground cover plants.

4. When species suitable for a particular site are being chosen, the consideration of local site factors requires specialist expertise.

6.3.5. Methods of Vegetation Establishment

Methods of establishment are available for many types of vegetation to suit a range of site conditions. Most herbaceous species are introduced as seed. The main exception is wild species with no commercial quantities of seed available, which can often be established from seed-rich topsoil from beneath the appropriate vegetation. Trees and shrubs are usually introduced as partly grown plants, though direct seeding is also widely practised.

1. Seeding methods include the usual drilling and broadcasting methods, using normal agriculture equipment. For large areas seed can be broadcast from an aircraft or helicopter. Difficult or inaccessible areas can be hydroseeded, using a tanker and pump to apply water-based slurry of seed, fertiliser, mulch and other additives such as soil stabilisers. Hydroseeding is a difficult technique requiring special skills.

2. Surface-sown seed can be protected from environmental extremes and erosion by a good mulch and stabiliser applied after the seed. They can be easily applied during the normal seeding process.

3. Seeding rates and inoculation of legumes with *Rhizobium* are important factors in the seeding process.

4. Methods of applying seed-rich litter and soil for establishing difficult plant communities are valuable.

5. The planting process for trees and shrubs involves first selecting the right sort of stock to use, that has been properly prepared for planting out by nursery. Several types of planting stock are available, each appropriate to a different situation.

6. The most critical stage for the plant during the planting process is between lifting in the nursery and planting out on-site. Exposed root systems are very susceptible to drought damage, and unless the plants are handled very carefully to prevent the root system drying out, the plants could be dead by the time they are planted.

Plants with a good undamaged root system can survive and grow well even when planted out into very adverse sites.

7. Planting methods include notch or mattock planting for small seeding and transplants, and pit planting for larger trees. Pocket planting is a special technique for establishing trees on very coarse rock spoils, where the tree is planted into a small pocket of fine material, such as peat or silt. There are special techniques for use in very arid areas, including irrigation and condensation traps.

8. Mulching with a granular or sheet material around each tree can aid establishment in several ways. It moderates extremes of soil temperature; it will suppress herbaceous weeds and control moisture conditions by reducing evaporation from the soil surface.

9. Weed control to suppress vigorous grass or weed growth around the young tree is essential.

10. Turfing is a useful way of introducing grass, herbaceous or shrub vegetation. Turf fragments or sods can be transplanted, usually in random or regular patterns over the site, from which wild species can radiate to colonise the site.

6.3.6. Management and After-care of Restored Land

If a reclaimed area is to develop successfully, it is essential that it is managed to ensure good soil and vegetation development. This is an integral and vital part of the whole reclamation scheme, and should be considered right from the planning stage. After-care should begin as soon as the planting and seeding are completed, and the plants begin to grow.

1. The management components are: monitoring to assess the progress and development of the soil and vegetation.

After-care, are the addition of fertilisers, *etc.*; maintenance of structural components; and the long-and short-term strategy.

2. Grassland will be managed by either grazing or mowing. Grazing management should aim to maintain productivity and stocking of the area, though it is also a useful management tool for amenity areas. Sheep and cattle are the most useful grazing animals. Both grazing and mowing will greatly influence the composition of the sward.

3. Woodland and forestry management should aim to maintain the optimum stand of trees for the purpose. Important components are replacing lost trees or thinning as necessary, weeding to reduce competition around young trees, and maintaining fertility.

4. In plantations there are many steps that can be taken to enhance the wildlife interest, even in those managed purely for timber production.

5. The build-up of soil nutrient, particularly nitrogen, can be monitored to assess the progress of the reclamation. Fertilising and vegetation management should aim to promote a steady increase in soil nitrogen to around 700 kg/ha. Grazing will encourage recycling of nutrients from the vegetation back to the soil.

(Coppin and Bradshaw, 1982)

6.4. The use and potential for Restoration blasting

The most unacceptable result of quarrying is often the final shape of the quarry faces resulting from digging and blasting during operation. There are two main uses of blasting. The first is in opening pits and facilitating the extraction of mineral. Second is the constructive use of blasting restoration, as a technique to create new more natural shapes in the final faces. Judicious blasting can produce these carefully designed and implemented to create features in keeping with a more natural landscape. Controlled blasting techniques are the most effective way to be applied to achieve this.

Figure 11. Restoration Blasting

6.4.1. Reasons for the use of Blasting Restoration

According to the Geoffrey Walton Practice, 1993 in Gunn, Bailey & Handley, 1997, p.20 it is stated that:

"Quarry faces may be potentially dangerous landforms. Death or serious injury to both people and livestock may arise from falls over quarry edges, large-scale slab failure of slopes and rock-fall. Hence, reclamation works should aim to reduce the risk of accident as well as to provide a visually acceptable result. Creating base slopes, mid slopes and top slopes with buttresses and headwalls are needed to reform the faces of the subjected quarry, and that will be reachable by using a wise restoration blasting technique".

In a modern quarry there is usually very little waste since the entire mineral can be utilised. However, the overburden must be removed and stored. This can be used in landscaped banks to hide the main quarry operations and it can easily be re-vegetated to enhance the screen.

The main environmental problems are often presented and determined by the quarry itself; by the bare rock face and quarry floor, or the pit flooded with water. At first sight, the reclamation of modern quarries poses many problems, but they also have a great deal of potential if the work is done wisely (Bradshaw and Chadwick, 1980).

In the context of the earlier objectives and the associated requirements, and also the circumstances which favour restoration blasting, (over the placement of overburden or operational waste materials on benches or the pit floor) (Figure No. 12), include:

- **Absence of suitable quantities or types of waste material.**
- **Requirement for available waste materials to be used for screening or back-fill.**
- **Inability to form the required slopes by directs excavation.**
- **Need to reclaim/treat perimeter slopes when waste materials are not available within the sequence of operations.**

(Gunn, Bailey and Handley, 1997)

Figure 12. Aerial view of the Blue Circle Quarry, Hope

6.5. The potential for the incorporation of Libyan traditions, and Roman and Greek ideas in quarry restoration of modern quarry sites

It is interesting to compare the similarities between natural mountain and dale-sides with the steep, sharp, worked slopes and the faces of former modern quarries. This comparison highlights the potential interest in considering the techniques used both now and in the past in converting and utilising these hard and unacceptable landforms to support domestic life.

In an arid country such as Libya the effects of year-long sunshine, and severe hot southern winds or cold western winds, throughout the year, have encouraged communities to maximise environmental protection within the landscape. Both natural and artificial structures (such as quarries) have been utilised. The potential impacts of extreme climatic conditions have forced people to seriously consider the different kinds of protection for buildings such as houses, and those for horticulture, agriculture and domestic animals. Indeed, prehistoric peoples used to live in caves for the same purposes, choosing places where they could be protected from the wind and the sun.

This approach for sheltering dwellings and other buildings and agricultural constructions such as domestic animals yards, pergolas for climbing plants and fruit trees plantation could be usefully considered as a potential and important after-use for restored quarry sites. A generalised diagram to illustrate this approach is shown in Figure 13. At the present time, this is an under-appreciated use for sites in the region. This clearly differs considerably from the UK where the environmental priorities and pressures are very different. In the UK the people do not experience such climatic extremes as in Libya and therefore using former quarry sites for domestic habitation is not a priority. The land area of quarries is greater in Libya compared to the UK, and so they likely lend themselves to the siting of perhaps whole villages in them. Most UK quarries tend to be deeper and are therefore are often filled prior to landscaping in the upper levels.

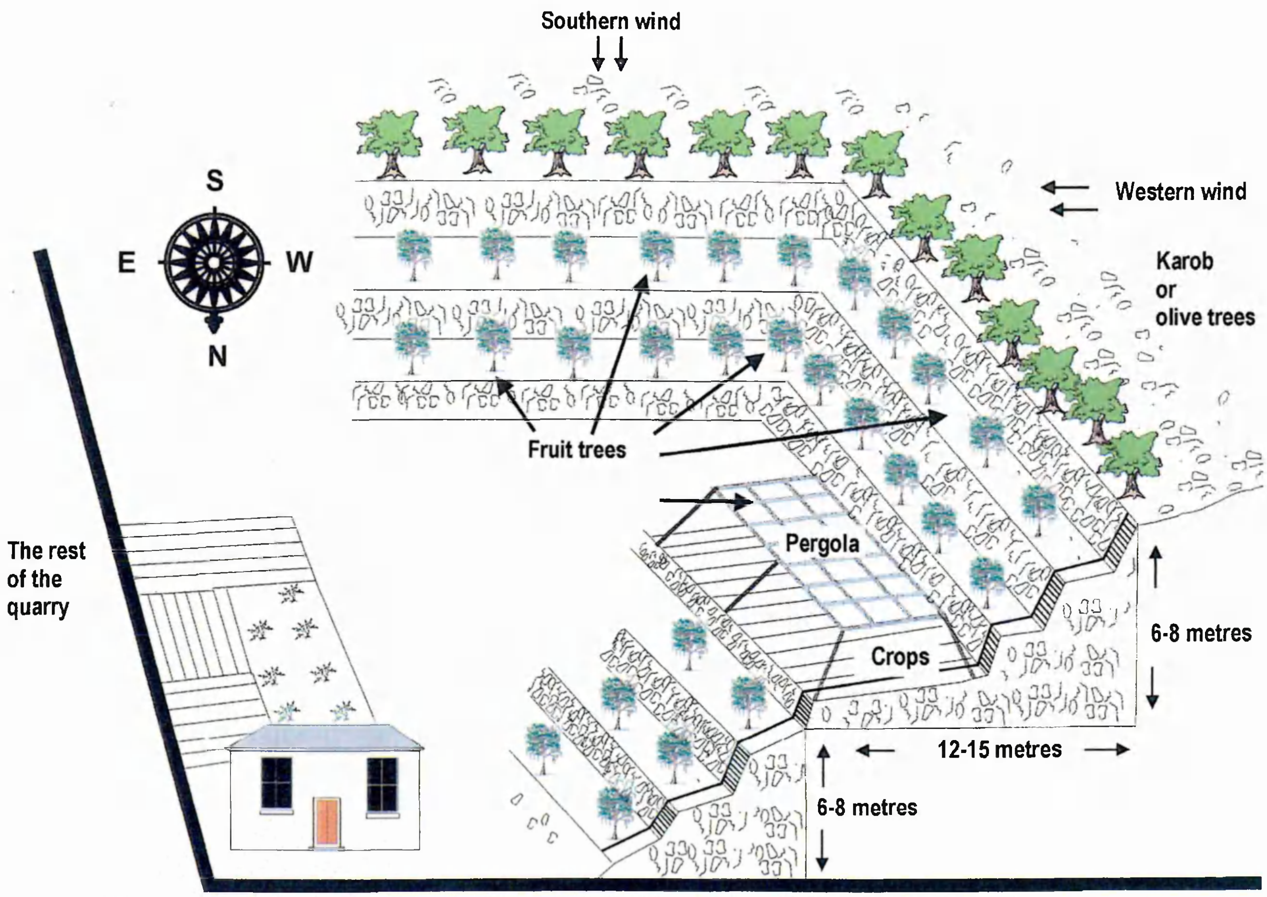


Figure 13. Representation of potential after-use of Libyan quarry site

Furthermore, the lesson of history is very informative. Both the Greeks and the Romans followed these same principles, establishing their cities in large, topographically protected areas. In Cyrene, which was one of the biggest Greek cities in the east region of Libya, they established the city buildings below a crescent of hills to provide natural protection from the hot southern and cold western winds, and to offer shade during the long afternoon summer-days. The subsequent civilisations, in similar climate, have no choice but to follow the same ideas even if involving artificially creating protection when building their castles and fortresses. Gaining long periods of shadow and protection from winds would be invaluable for the Bedouin tribes who live in the countryside around the cities in much of Libya. The tribes that colonise the valleys still follow the same ideas especially on the west side of a valley and the southern, curved valley side, which has been created naturally as part of the development of the valley system.

6.5.1. The Role of local people

The local people are very co-operative in such ventures since most of them are related and share in the land's produce. Their activities begin in the early Spring season and continue until the end of the Summer, using their simple tools they work the land and complete many different tasks such as sheep and goat (wool) shearing. They co-operate to restore, build up and extend their farms, generally working in-groups not less than twenty people each. They work according to the requirement of the site so as to make it usable. Some of them need annual restoration; some need extension; and some are new and need basic constructions such as benching, plantations, establishing of terraces, buildings and installation of irrigation systems.

These types of works are widely spread throughout the deep valleys of the region formerly exploited by previous civilisations. Particularly relevant to the present study, the local tribes influence the quarry contract clauses and policies in terms of future restoration activities if the quarry is located on their land. They may already think of using the land, as their ancestors did two thousand years ago, of the quarry site for domestic purposes, establishing hanging gardens for the commercial production of fruits, herbs *etc.*, as well as, for building houses, keeping domestic animals and beehives. Such enterprises as these must be protected from the climatic elements previously outlined. This kind of protection can easily be afforded within former quarries by utilising the high walls / cliffs / faces left at the end of the quarrying operations.

6.6. How to simulate the idea at a former quarry?

The remains of Roman and Greek cities give clear evidence of this topographical use of sites. The present-day Libyan Bedouin methods similarly utilise the landscape in this way. By combining Libyan Bedouin methods with the modern process of restoration, another and distinctive type of quarry restoration becomes possible. This approach reflects that of earlier civilisations, but places this environmental function into a modern, contemporary context. Furthermore, and very importantly, this method of site restoration blends with the natural landscape, and reflects the needs and requirements of local people and the climatic constraints of this extreme environment.

Advocating of this new approach highlights the need to recognise the differences in landscape, environment, and culture between the two countries being studied - Libya and the UK. These differences must be considered both in terms of the aims and objectives of restoration and indeed throughout the process itself. The background to the UK situation is around two thousand years of increasingly intensive human activity and increasing population. There is now a high population density and a potential shortage of land and a serious degree of vulnerability in for example the ecological natural resource. The backdrop to this is a landscape of largely fertile soils, and usually plentiful water. These factors have encouraged and allowed people to exploit almost every available area of land. Furthermore, the demand for limestone for building and other industrial and construction purposes has been huge.

Conservation restoration of disused quarries is clearly a favourable option. This can use techniques such as restoration blasting. Quarry restoration done this way needs plenty of boulders for benching and for covering the quarry faces. Restoration blasting can be used to produce suitable boulders for conservation restoration of former quarries.

Contrasting with the UK, countries like Libya, with arid conditions, have severe constraints placed on people's activities. They are essentially restricted to areas where water is available. In times past, the Libyan people were often relatively disorganised because of invasions by other peoples, and because of severe diseases which attacked their land. As a result, most of the countryside is still relatively virgin and uncultivated. Lack of vegetation makes the gathering of boulders for benching and covering the walls of the quarry faces very easy with low cost. It is relatively easy and quick since they are gathered from the surface of the ground.

6.7. Methodology

The effective use of this approach to restoration will depend on the residual engineering factors such as the final shape and the height of the quarry faces, the width of the benches as well as the relief of the quarry floor. These factors will determine what must be applied and the precise way it should be done. In the proposed project, for former limestone quarry restoration, the following steps should be carried out to achieve an acceptable final result:

1. Presume that the final shape of the site produces the dimensions specified in the contract conditions i.e. the walls not to exceed 6-8 m in height, the benches not to exceed 12-15 m in width.

2. The final access point into the former quarry will be from the north, as one of the contract conditions.

3. The floor of the quarry must be flat to make restoration work easier.

4. Site drainage should be so as to avoid flooding.

Figures 14 and 15 show the quarry restoration and uses at a hundred and forty-eight quarry sites in the two case study countries (Libya and the UK). These have a total of a hundred and ninety-seven restoration sub-sections. (See Appendix No. 3).

6.8. Evaluation of restoration to Conservation and Recreation / Amenity use of sites in Libya and the UK

This part of the study concentrates on various types of restoration that may reflect the trends in the desires of people and hence the plans being prepared for the restoration. This is generally in accordance with the relevant strategy of the country and the hopes of the people. The culture of the people, together with political, economic and climatic conditions, generally determine what is desired, planned and implemented in the case study sites in the two countries.

6.8.1. The UK's Quarries

(See Figure 14)

Table No. 4

The UK's Quarries. (Data for 78 Quarries)			
Limestone	**Clay**	**Sandstone**	**Sand & Gravel**
71	**0**	**5**	**2**

(See Appendix No. 3 for a total of 112 restoration sub-sections)
Was obtained by e-mail contact with Minerals Planning officers of UK counties known to have limestone deposits, based on the geology of the UK (See Appendix No. 5), together with some to managers of large aggregates companies known to operate some limestone quarries. (Directory of Mining & Quarrying, UK, 1998).

In the UK, seventy-eight quarries with a total of a hundred and twelve restoration sub-sections have been gathered to examine the types of restoration and land-uses produced in accordance with the UK minerals planning bodies.

The result of the Evaluation of the UK sites (Figure 14) are summarised as follow:

1. (31) sites left to re-colonise naturally, which means that no restoration has been done in each one of them.
2. (10) sites restored to agriculture end-uses, i. e. grain crops & animal feed.
3. (3) sites restored to low level restoration, for caravan camping park.
4. (7) sites restored to landscape and planting restoration, i. e. screening.
5. (14) sites restored to nature conservation / amenity as a method of returning the site to the natural images (simulation).
6. (8) sites restored to water areas, some of them as lakes for recreation and the others for water storage.
7. (6) sites restored to wildlife and forest areas to recreate an ideal environment for all animal species.
8. (4) sites restored by retaining the faces of the quarry to reduce the visual impacts, and to stabilise the loose faces and prevent them of falling.
9. (4) sites converted (no restoration) for commercial uses such as new cars storage, aggregate, route materials, and construction material industries and stores.
10. (1) site converted to be a pasture area.
11. (6) sites back-filled with wastes such as construction waste and domestic waste.
12. (7) sites have their own future restoration plans because they are still active.
13. (11) sites with no information about their restoration plans.

Fig. No. 14. Quarry restoration & land-uses in the UK. Data for 78 UK quarry sites with a total of 112 restoration sub-sections.

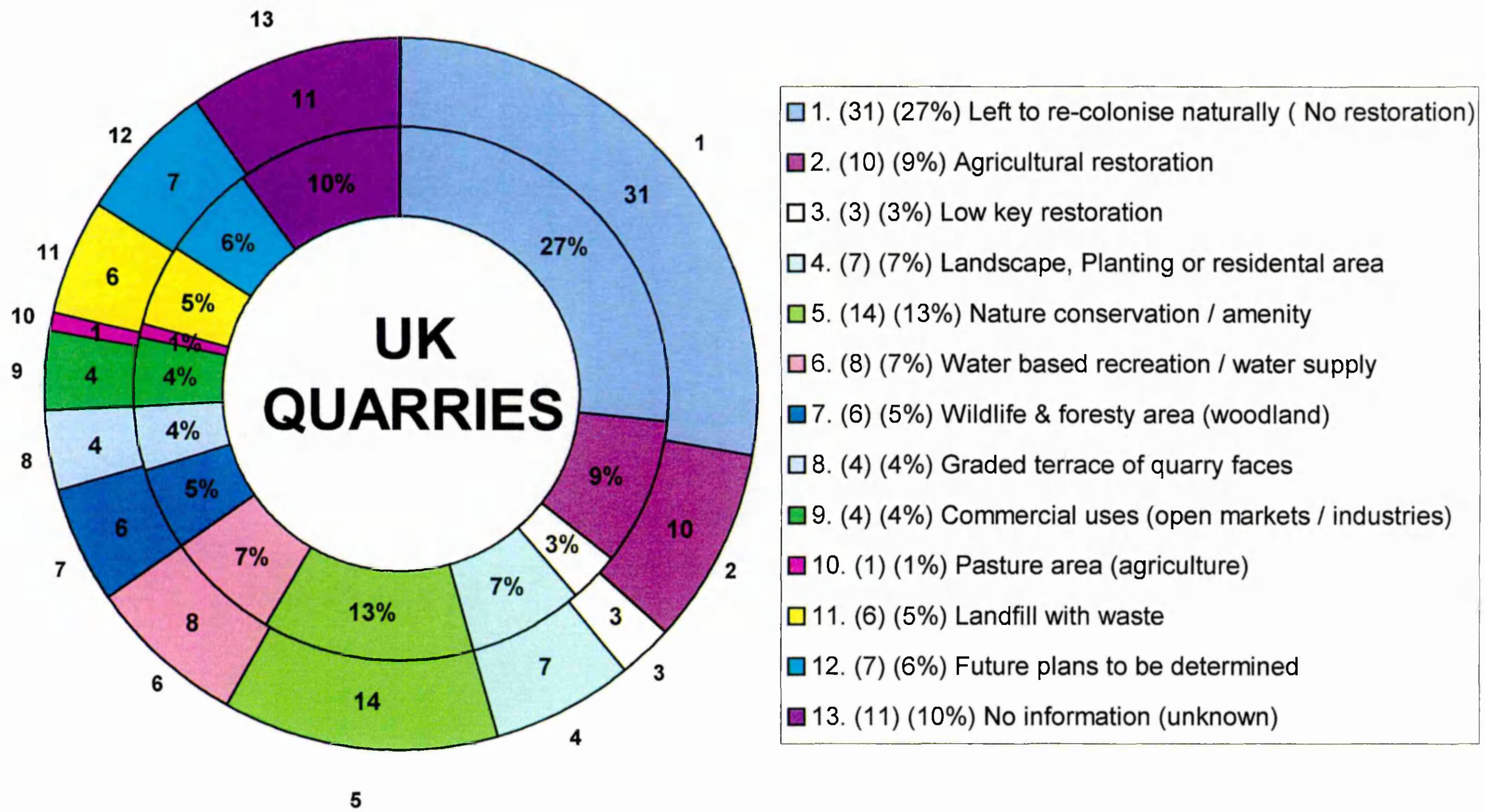
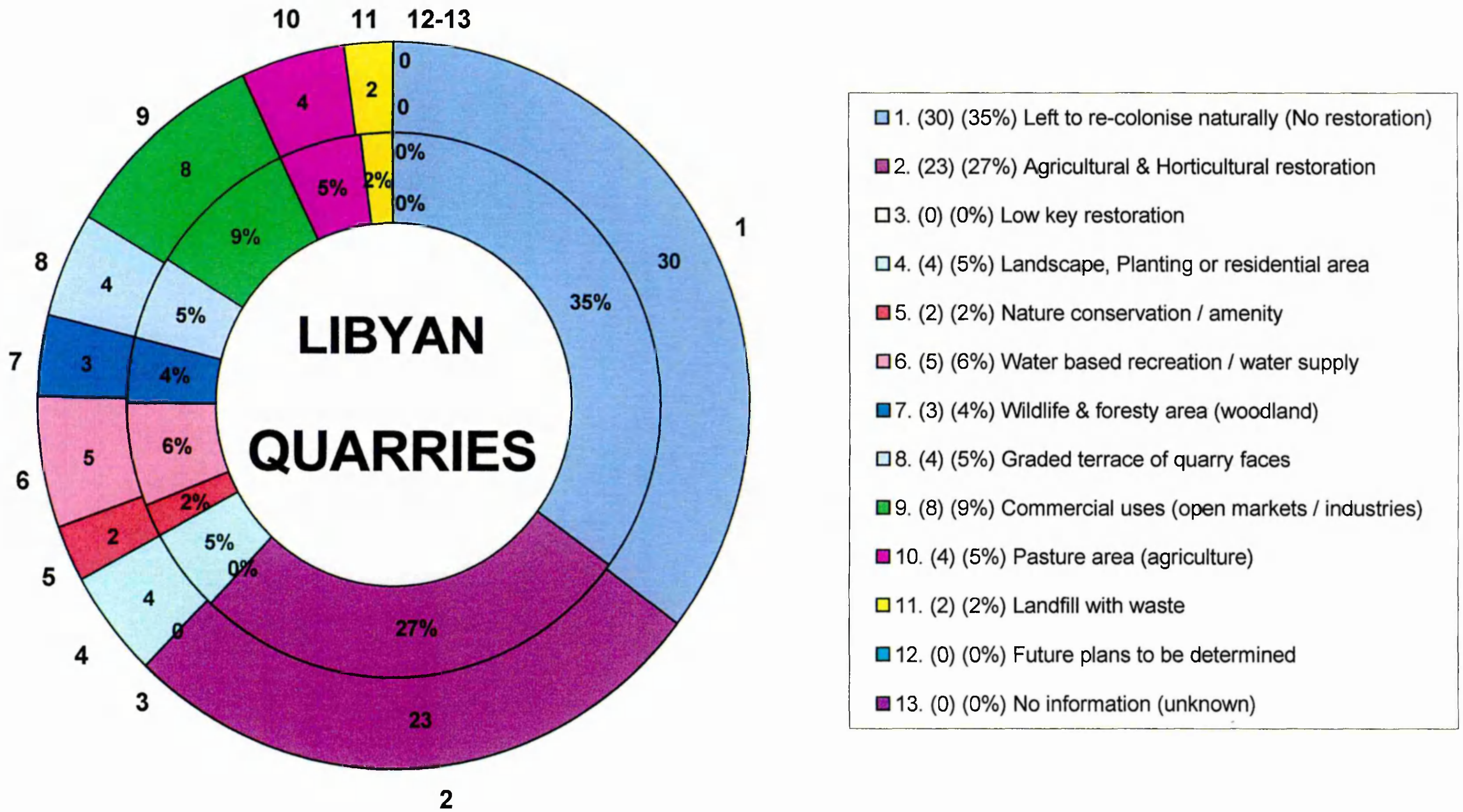


Fig. No. 15. Quarry restoration & land uses in Libya. Data for 70 Libyan quarry sites with total of 85 restoration sub-sections.



6.8.2. Libyan Quarries:

(See Figure 15)

Table No. 5

The Libyan Quarries. (Data for 70 Quarries) (Some of the quarries producing mixed of two materials)			
Limestone	Limestone & Clay	Gypsum & Chalk	Clay
49	6	12	5

(See Appendix No. 3 for a total of 85 restoration sub-sections)
Was obtained by requesting such data from the Libyan Cement Company & Libyan Industrial Research Centre, using all methods of modern communications.

In Libya, seventy quarry sites, with a total of eighty-five restoration sub-sections, have been gathered to introduce the types of restoration and land uses in accordance with wishes of the Libyan people and in the context of the relevant strategies of the country. These restorations are summarised below:

1. (30) sites left to re-colonise naturally (no restoration); in the Libyan case they are left without restoration because they are located far away from the people and activities of local organisations.
2. (23) sites restored to agriculture and horticulture uses (a very important demand from the local Bedouin people).
3. No sites noted as receiving low level restoration.
4. (4) sites restored to landscape, planting and residential areas by the local people and the local government bodies.
5. (2) sites restored to nature conservation and amenity, particularly, these close to tourist areas.
6. (5) sites converted to water area for recreation and water storage for cattle drinking.
7. (3) sites restored to wildlife and forest areas (woodland).
8. (4) sites restored by retaining the quarry faces to reduce any risks due to the collapsing edges of the quarry.
9. (8) sites converted to commercial and industrial uses such as cattle markets, agricultural and horticultural produce markets and industrial units, for construction and building materials.
10. (4) sites converted to pasture area, particularly in shallow quarries with faces not to exceed 8m in height.
11. (2) sites converted to domestic waste dump and recycling units.

6.9. Results

From the above information on the number of finished, semi-finished and active quarries in the two countries of Libya and the UK, data have been extracted. This information is used to demonstrate the types of restoration being implemented in the two countries. This is summarised into the following:

1. As shown in the two diagrams (Figures 14 and 15), the majority of the quarries have been left to re-colonise naturally or without restoration intervention.

2. The agricultural and horticultural restoration seems to follow the culture of the people and their life style. In the UK study sites, agricultural restoration is less than 10% with use, for specific kinds of crops and animal feed in particular.

The restoration and after-use in Libya and in the UK are presented for comparison in Table·4.

Table 6. Comparison of restoration after-use in Libya and in the UK

Types of restoration	UK	Libya	Comment
1. Left to re-colonise naturally (No restoration)	27%	35%	*Higher in Libya.*
2. Agricultural & Horticultural restoration	9%	27%	*Significally higher in Libya.(See Figure No. 16*
3. Low key restoration	3%	0%	
4. Landscape, Planting	7%	5%	
5. Nature conservation / amenity	13%	2%	*Significally higher in the UK.*
6. Water based recreation / water supply	7%	6%	
7. Wildlife & foresty area (woodland)	5%	4%	
8. Graded terrace of quarry bench (horticulture)	4%	5%	
9. Commercial uses (open market / industries)	4%	9%	
10. Pasture area (agriculture)	1%	5%	*Higher in Libya.*
11. Landfill with waste	5%	2%	*Higher in the UK.*
12. Future plans to be determined	6%	0%	*Interestingly higher in the UK.*
13. No information (unknown)	10%	0%	*Interestingly higher in the UK.*

In the Libyan study sites in both finished and unfinished sites, there are agriculture and horticulture restorations with associated domestic benefits. There are twenty-three sites (27%) that have been involved in this kind of restoration. It seems therefore that number of restorations applied in this way reflects people's activities and interests. They clearly look to gain benefits from their mineral exploited lands. So it seems from the samples that there are major differences as well as some similarities between approaches in the two Countries. It can be argued that these reflect the differing issues and priorities noted earlier. They also and particularly follow from the contrasting environmental and especially climatic circumstances. In the UK more sites are used for landfill or restored to nature conservation. In Libya, a greater proportion of sites are used for horticulture and / or agricultural use. (In former times quarry sites were also used for domestic housing too).

It is interesting to note that in both situations approximately the same proportions of sites are left to follow passive ecological succession - i.e. abandoned and not restored. Of course these may be turned to another use at a later date, and many will have 'accidental' nature conservation value.

Nature conservation and amenity uses were higher in the UK. Landfill with waste was also higher in the UK, but in both countries it was a surprisingly small proportion of the restored sites.

It is fully accepted that the samples used were of limited extent and reflected those for which information was available on the time of the research.

A broader or different set of sites might generate a slightly changed profile for each country.

This said, the samples were quite large and the research attempted to make them as representative as possible.

Figure No. 16 Restoration to Agriculture, Bolsovermoor Quarry, Bolsover, UK.

Chapter 7. Case Studies

Case Study No. 1

Darnah Cement Plant
(Libya)

Case Study No. 2

Hope Valley Cement Works
(UK)

7.1. Darnah Cement Plant and its industrial projects (Quarries)

Darnah Cement Plant was selected because it is a typical example of a Libyan cement manufacturing site. It is also of interest and relevance because the cement manufacture and the limestone and clay quarries are located in close proximity. The scale operation and both the restoration and work practice are typical for the Libyan industry. The location of the site near my home town of Darnah, and close to my workplace made it convenient for study.

7.1.1. Plant Location

The cement plant is located nineteen kilometres to the southeast of the town of Darnah, along the main Darnah - Tobruk motorway. (Figures 17-18).

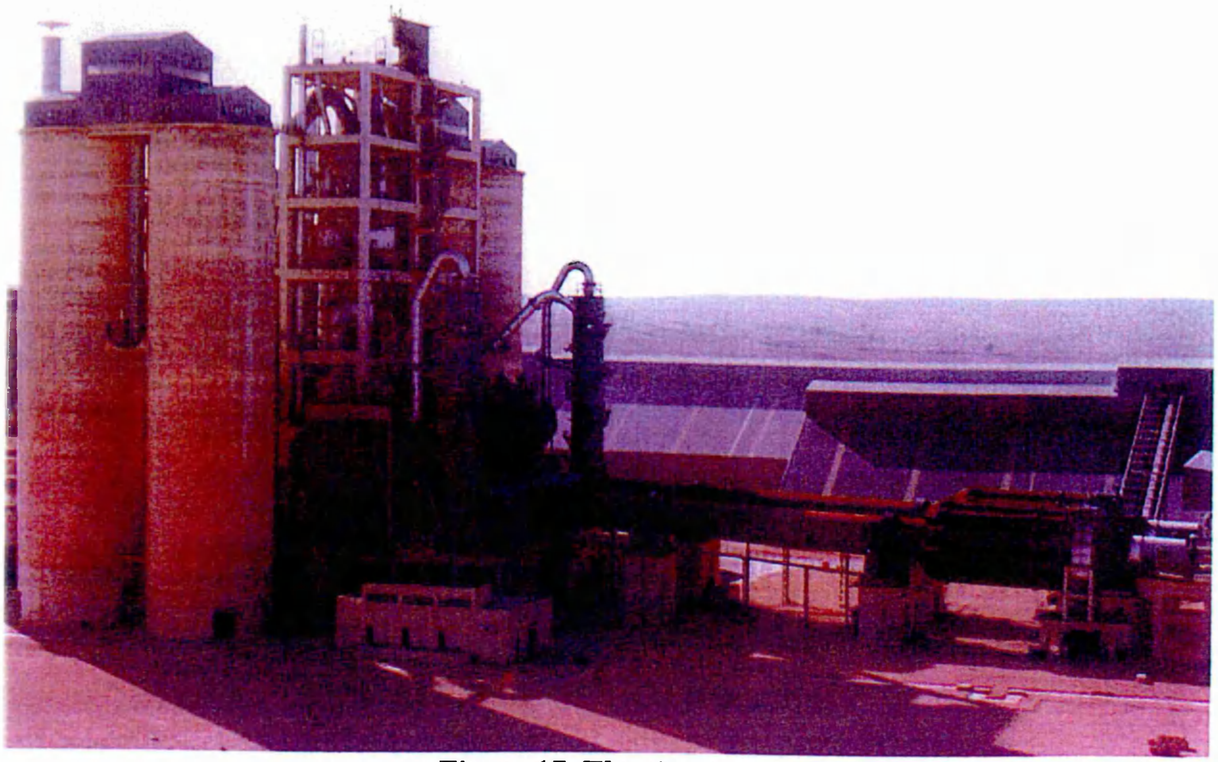


Figure 17. The site

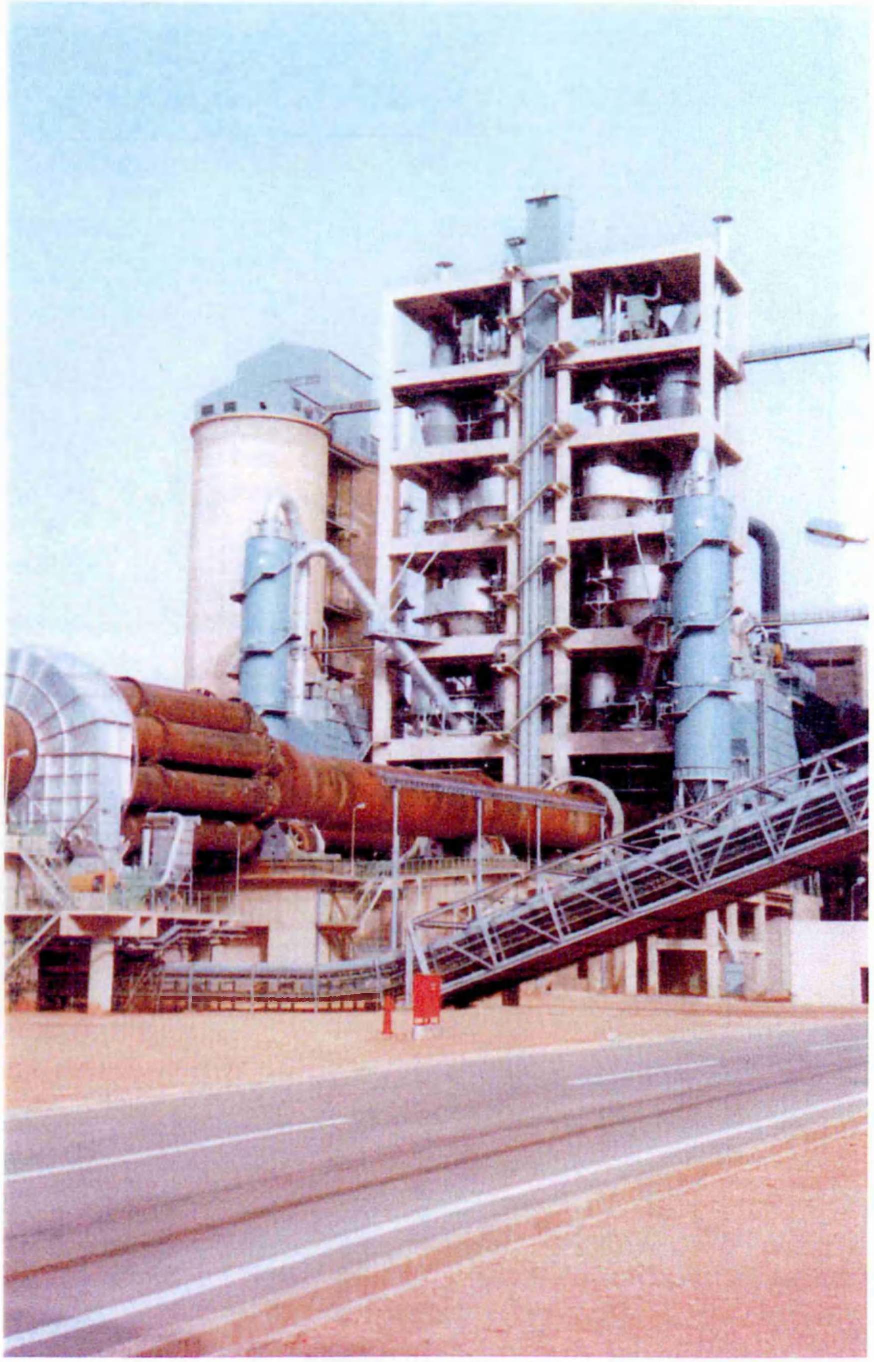


Figure 18. The site

The site was selected for the cement plant on the basis of the geological assessment of the area. Other factors which, influenced the seting of the cement plant were:

a) The distance between the cement plant and limestone deposits should not exceed 2 km.

b) The distance between the cement plant and the motorway is approx. 0.7 km.

c) The soil characteristics were suitable for foundation requirements and the ground is suitable for direct foundation for building.

d) The ground slope averages 1.5 %, and the cost of levelling earthworks connected with site preparation would consequently be at a low coast.

e) There should be power supply to the plant.

f) There should be the potential for adequate water supply and sewage disposal.

g) The site should be located at an appropriate distance from the neighbourhood of cultivated and inhabited areas (considered distance 5-8km).

h) The conditions for transportation of materials and equipment for the construction and erection of the cement plant, conditions are favourable proximity to the motorway and the port, and ground conditions were suitable.

i) The existince housing and overhead power lines some 5km away providing fairly easy conection to the local services of power and water.

7.1.2. Potential extension to the plant

While developing the plant layout, attention was paid to creating suitable conditions for future extension to the Darnah Cement Plant. This potential extension was anticipated in the capacity, in terms of adding a second production line to the one currently in operation. (Darnah Cement Plant, 1988, Trans.)

7.1.3. Environmental protection in relation to the plant

As indicated there are no cultivated lands or residential areas in the close proximity of Dernah cement plant. Hence any potential harm of the cement plant to the local human environment is minimal and limited to quarrying emissions and visual impacts. However, in accordance with the government standards, the dust emissions to the atmosphere were closely restricted. This was to be attained through the application of highly efficient filter installations.

The sectors of the plant emitting the greatest amount of dust such as kilns, primary crusher and cement mill were equipped with high efficiency electrostatic precipitators. The concentration of the dust in the emitted gases will not exceed 100 mg/m^3. This is lower value than the permissible level (120 mg/m^3).

In order to further limit dust emission, all materials such as gypsum, clinker and clay was placed in closed storage. (Darnah Cement Pant, 1988, Trans.)

7.2. Limestone Quarry

The limestone quarry project was carefully designed and planned. The mining plan for the clay quarry was the subject of a separate study.

Average limestone requirement in the state of natural humidity amount to 1,094,000 tonne / year. Modern mining technology was proposed for the project enabling great concentration of mining work. There is consideration of increasing output / if need be / reducing manpower and improving work safety as may be necessary.

7.2.1. The Limestone Deposit

Proven limestone deposits, located 19km southeast from Darnah, belong to the Darnah and Al-Faidiyah formations (Lower Miocene - Upper Oligocene).

From the surface of the investigated area is a covering of a limestone crust with a thickness ranging from 0 to 6.1 metres. Below it occurs white detrital limestone, poorly compact and soft. In some places there occurs either compact or crystalline limestone of greater hardness.

The area of the deposit designated for exploitation was 1,858,820m^2. The deposit depth within the exploitation area boundaries varies from 0 to 35m. The mining field designated for exploitation was characterised by the best qualitative parameters according to technological criteria.

The selected exploitation field is to be worked on two bench levels at the same time. Due to the geological structure of the limestone, and the necessity for driving trucks on a hard rock surface and with uniform wall height on both bench levels, the following heights have been adopted:

Bench Level 1 305.0 m above the sea level.

Bench Level 2 290.0 m above the sea level.

Within the boundaries of the exploitation field the limestone deposit is characterised by simple geological structure. The deposit is not covered with overburden; therefore it is easily accessible with gentle slopes. (Darnah Cement Plant, 1988, Trans.)

7.2.2. Qualitative characteristics of the limestone

Chemical composition of limestone from bench level 1 (305.0 m) and bench level 2- (290.0 m) within the boundaries of exploitation area, and the average from both levels together is presented as follows:

Table 7. The chemical composition of limestone from level 1 & 2

L.O.I (Loss On Ignition), **SM** (Silica Modulus), **AM** (Alumina Modulus).

Item	**Content %**		
	Level 1	Level 2	Level 1+2
L.O.I	**42.59**	**43.01**	**42.82**
SiO^2	**1.88**	**0.89**	**1.16**
Fe^2o^3	**0.21**	**0.16**	**0.18**
Al^2o^3	**0.60**	**0.43**	**0.51**
CaO	**53.77**	**54.64**	**54.24**
MgO	**0.39**	**0.25**	**0.31**
SO^3	**0.08**	**0.08**	**0.08**
Na^2O	**0.08**	**0.06**	**0.07**
K^2O	**0.08**	**0.04**	**0.05**
Cl	**0.005**	**0.008**	**0.006**
SM	**2.32**	**0.51**	**1.68**
AM	**2.96**	**2.69**	**2.83**

(After Libyan Industrial Research Centre Report, 1983)

Mean bulk density of the limestone = **2. 47 t / m^3**.

The limestone deposits show only very slight variations of the chemical composition, due to this there will be no difficulties in obtaining the material of required chemical composition.

It should also be noted that simultaneous exploitation of both levels will also contributed to blending the chemical composition of the raw material and will, therefore, cause a further decrease in qualitative changes of limestone.

If a part of the limestone is found with lower portion of CaO content, limestone from other parts of the region with greater CaO content will be added to blend the limestone mix to meet the CaO content requirement for cement manufactory.

7.2.3. Exploitation of the reserves of raw material

Limestone deposit resources calculated in the geological specification amount to:

Bench Level 1	**305. 0 m**	**- 40, 287, 853 tonnes**
Bench Level 2	**290. 0 m**	**- 56, 962, 275 tonnes**
Total of benches levels 1+2:		**97, 250, 128 tonnes**

Taking into consideration uneven working of the deposit to the base of bench level 2, leaving out certain marginal areas of the deposit, characterised by shallow depth and outermost parts of the deposit (from the northern side). They are characterised by an increased MgO content, it is assumed that the reserves will be diminished by 5% approx., and will be amount to:

Bench Level 1	**38, 273, 460 tonnes**	**= 41. 4 %**
Bench Level 2	**54, 114, 160 tonnes**	**= 58. 6 %**
Total	**92, 387, 620 tonnes**	

The resources underlying bench level 2 (290.0 m) will not be worked because of very variable depth, uneven base, and necessity of leaving a certain thickness of the layer of limestone over the clay capping *etc.* Therefore, they will not be taken into consideration in further deliberations.

There exists, however, the possibility of extending the exploitation area of bench levels 1 and 2 at the annual output of 1,116,000 tonne / year, that will ensure exploitation for the period:

$$\frac{\mathbf{92,387,620}}{\mathbf{01,116,000}} \; \boxed{= \mathbf{82.8} = \mathbf{83\ years.}}$$

Table 8. Total limestone output

Time	Average		Maximum	
	tonne	m^3	tonne	m^3
annual	1,116,000	451,820	1,202,000	486,640
per day	3,986	1,614	4,292	1,738
per shift	1,993	807	2,146	869
per hour	285	115.4	306.6	124.1

(After Libyan Industrial Research Centre Report, 1983)

Table 9. The limestone output from both bench levels separately:

Time	Average / tonne		Maximum / tonne	
	Level 1	Level 2	Level 1	Level 2
annual	468,720	647,280	504,840	697,160
per day	1,674	2,312	1,803	2,490
per shift	837	1,156	902	1,245
per hour	119.6	165.4	128.8	177.8

(After Libyan Industrial Research Centre Report, 1983)

7.2.4. Opening of the Quarry

7.2.4.1. Preparatory works in the quarry

Due to the blending of the variable chemical composition of the raw materials, variable wall heights in the quarry and greater flexibility of operation is opened and exploit two bench levels at the same time.

Taking into consideration the proven depth of the deposit, exploited the limestone in two bench levels as follows:

Bench level 1 - 305. 0 m, walls height 0-20 m, average 12. 49 m.

Bench level 2 - 290. 0 m, walls height 0-15 m, average 12. 41 m.

It is proposed to open out both bench levels at the same time, from the western side, i.e. most favourable in terms of:

- Relatively little preparatory work connected with the opening.
- Short transport route from the quarry to the crushing department.
- Very good chemical composition of the deposit in this area.
- In line with the views of local people.

7.2.4.2. System of exploitation

The quarry will be an open pit following the outcrop of the limestone. A face system proposed to be applied along the whole length of the working front. The length of face on bench level 1 (305.0 m) will range between 285 - 1300 m, and the height from 0 to 20 m, average (12. 49). The length of the exploitation face on bench level 2 (290.0 m) will range between 350 - 1450 m, and the height from 0 to 15 m, average (12. 41m). Quarrying is to be carried out in the following way with the use of modern machines:

- Blasting by means of explosives.
- Loading with the use of hydraulic pushes shovels.
- Transport to the crusher by means of heavy dump trucks.

After opening both bench levels, their exploitation will be carried out in the same time from west to east in accordance with the desire of local people for the implementation of future restoration plans. (Figure 19) (Darnah Cement Plant, 1988, Trans.)

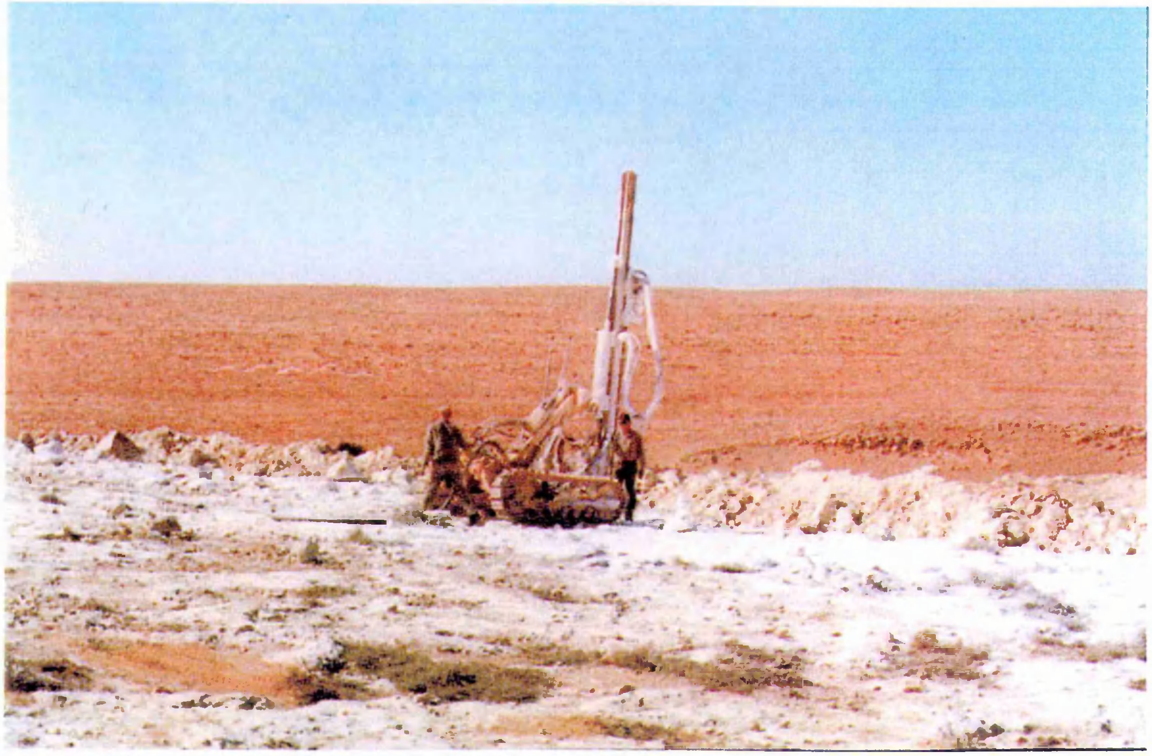


Figure 19. Opening the limestone quarry

7.3. The Clay Quarry

The clay quarry is located approximately 18 km, in a straight line, from the Darnah Cement Plant and provides the clay of appropriate composition quality nescessary for the cement making process. Exploitation of the clay deposit is some 8km to the north running from east to west between Al Dahar Al Hamer and Martubah (Map No. 4, location 1).

The nearest inhabited locality of Martubah is situated 18 km, in a straight line, to the north east of the deposit. The deposit is part of a vast valley, which is an extension of Wadi Al Muhain, and it is called Chawt Al-Mussalliqun. The surface of the deposit is overgrown with tufts of desert plants. In a considerable area surrounding the deposit there are no human dwellings except for these of some seasonal shepherd's camps. Of the clay deposits discovered in this region, the Mussalliqun deposit is the most suitable raw material due to:

- Appropriate quality.
- Large volume of the deposit.
- Possibility of discovering more deposit.
- Simple geological structure.
- Easy exploitation conditions.

The advantages in terms of the occurrence and quality of the deposit as described above are sufficient reasons for the construction of the quarry. The only drawback to this location is the travel distance. Along the designated route for raw material transportation, from the quarry to Darnah Cement Plant, is approximately 20.5km.

7.3.1. Geological characteristics of the Clay quarry

The Tertiary Mussalliqun clay deposit is a sedimentary formation comprising several beds. The area of the deposit, within the geological boundaries, amounts to 1,493,136,15 m^2, and has a thickness varying from 9.5m to 31m of which some 10m is to be exploited. The quality of the clay decreases with depth and has a thin cover (0.2) of humus bearing overburden (Figure 20). (Darnah Cement Plant, 1988, Trans.)

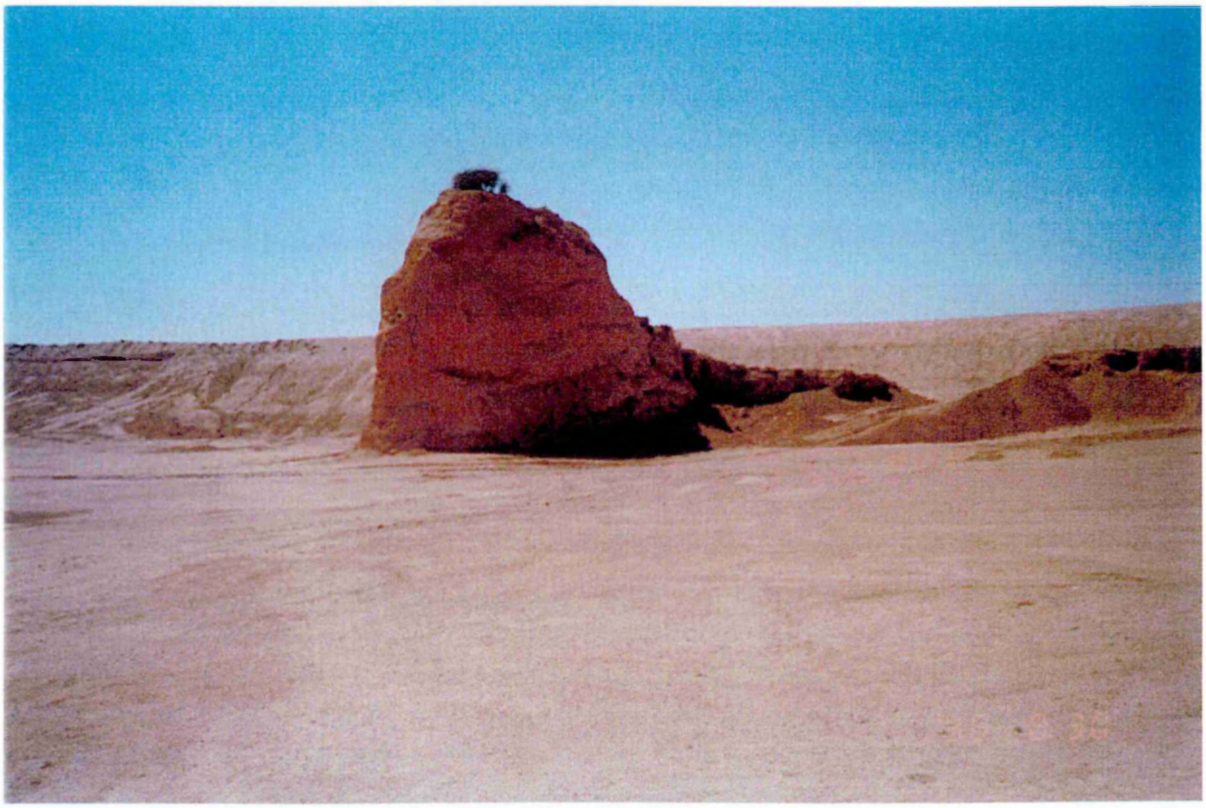
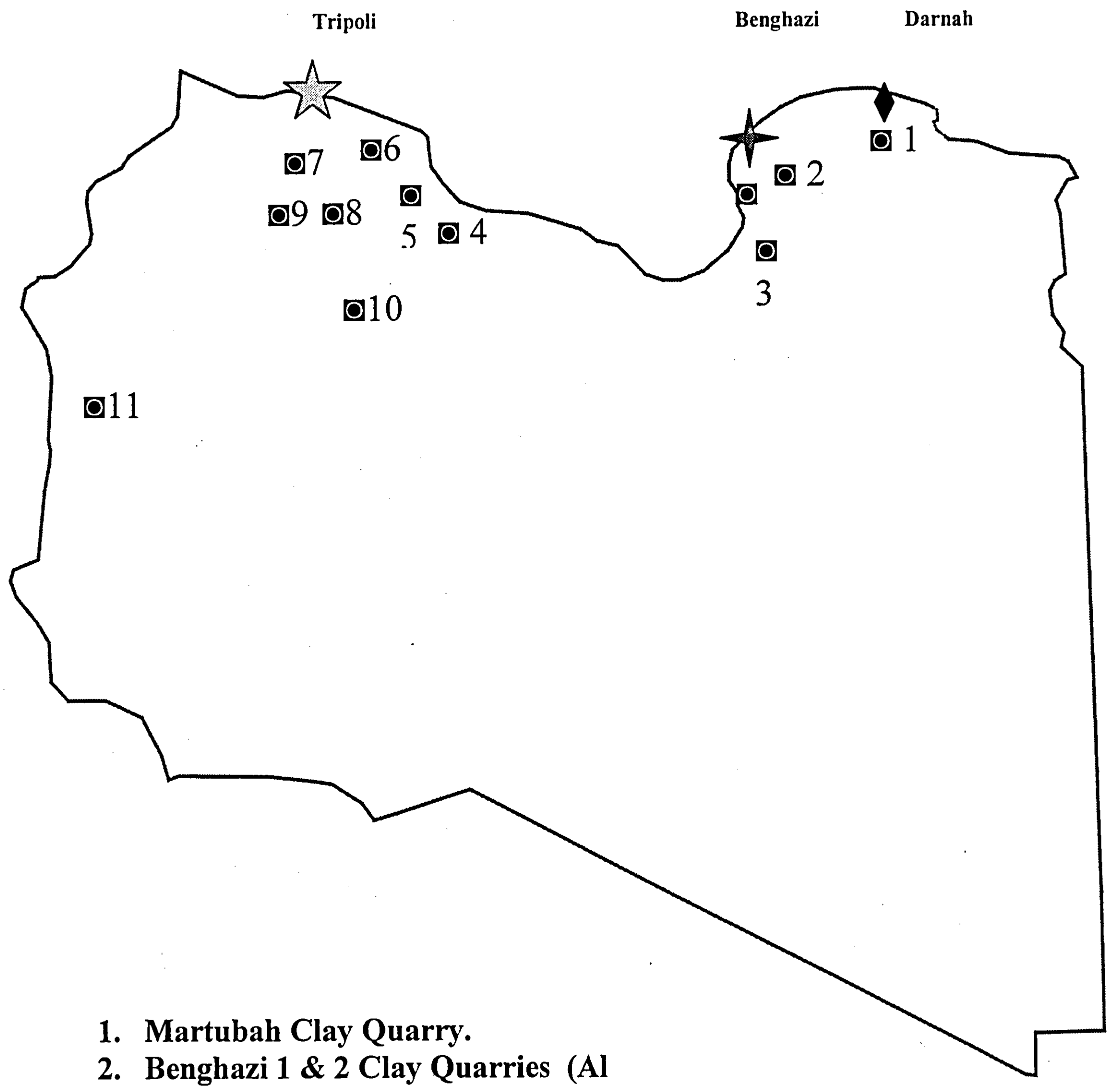


Figure 20. Clay deposits from 9.5m to 31m

The surface of the deposit is flat, spreading out from west to east, its dip being 5 degrees.

Map No. (4) Libyan Clay Sites



1. **Martubah Clay Quarry.**
2. **Benghazi 1 & 2 Clay Quarries (Al Hawwari).**
3. **Ajdabiya Clay Quarry.**
4. **Al Qaddaniyah Clay Quarry.**
5. **Ras el Margheb Clay Quarry.**
6. **Ras el Manubia Clay Quarry.**
7. **Al Juma Clay Quarry.**
8. **Ras el Kabir Clay Quarry.**
9. **Abu Ghaylan Clay Quarry.**
10. **Hasan Clay Quarry.**
11. **Wadi Ghan Clay Quarry.**

7.3.2. Qualitative characteristics of clays:

The chemical composition of the deposit within the exploitation boundaries is presented in the table below (Table 7).

Table 10. Chemical composition of the Clay

L.O.I (Loss On Ignition), **SM** (Silica Modulus), **AM** (Alumina Modulus).

Item	Component content in %		
	Min.	Max.	Mean.
L.O.I	17.17	25.86	20.33
SiO^2	26.64	43.30	37.95
Fe^2O^3	3.27	5.04	4.51
Al^2O^3	8.40	13.17	10.76
CaO	15.92	30.33	20.70
MgO	1.65	3.34	2.35
SO^3	0.04	0.50	0.16
K^2O	1.31	2.25	1.71
Na^2O	0.26	1.03	0.58
Cl	0,007	0.290	0.162
SM	2.05	2.90	2.49
AM	1.76	3.06	2.39

(After Libyan Industrial Research Centre Report, 1991)

From the above table it can be concluded that the deposit is chemically homogeneous so there is no need for selective exploitation. According to the technological requirement for cement manufacture the proportion of clay in the raw material should range from 32% to 35%.

7.3.3. Geological deposit reserves

The geological reserves of the deposit, calculated by means of the block method are as follows: **14, 931, 391, 5 m^3** which taking into consideration the weight by volume: 2.10 **t / m^3 gives 31, 355, 863 tonnes.** (The overburden covering the deposit is of minimum percentage).

7.3.4. Exploitation reserves

The exploitation boundaries correspond closely to the geological boundaries. The area of the deposit within the boundaries of exploitation is: **1, 493, 136, 15 m^2**

For technological-mining reasons the deposit is divided into two fields. The western fields are separated from the eastern ones by a dirt road for which a protecting pillar has been left. (See Figure 20a)

In the deposit a 10m high face has been selected which is justified by the maximum reach of the excavator.

The overburden is made up of clays and organic material. The overburden volume within the working boundaries of the deposit, amount to: **298, 600 m^3**. Taking into consideration the quantity of overburden **298, 600 m^3 = 627, 000 tonnes.** The total exploitation resources will amount to:

30, 728, 800 tonnes Made up from: **West Field = 20, 588, 300 tonnes**

East Field = 10, 140, 500 tonnes

30, 728, 800 tonnes

7.3.5. Raw material demand

The average yearly demand of raw material will total **1, 600, 000** tonnes per annum, which is to support the output of **1, 000, 000** tonnes of cement per annum. The average percentage input of clays in relation to the total demand for raw materials will amount to 33%, which is **528, 000 t/year.**

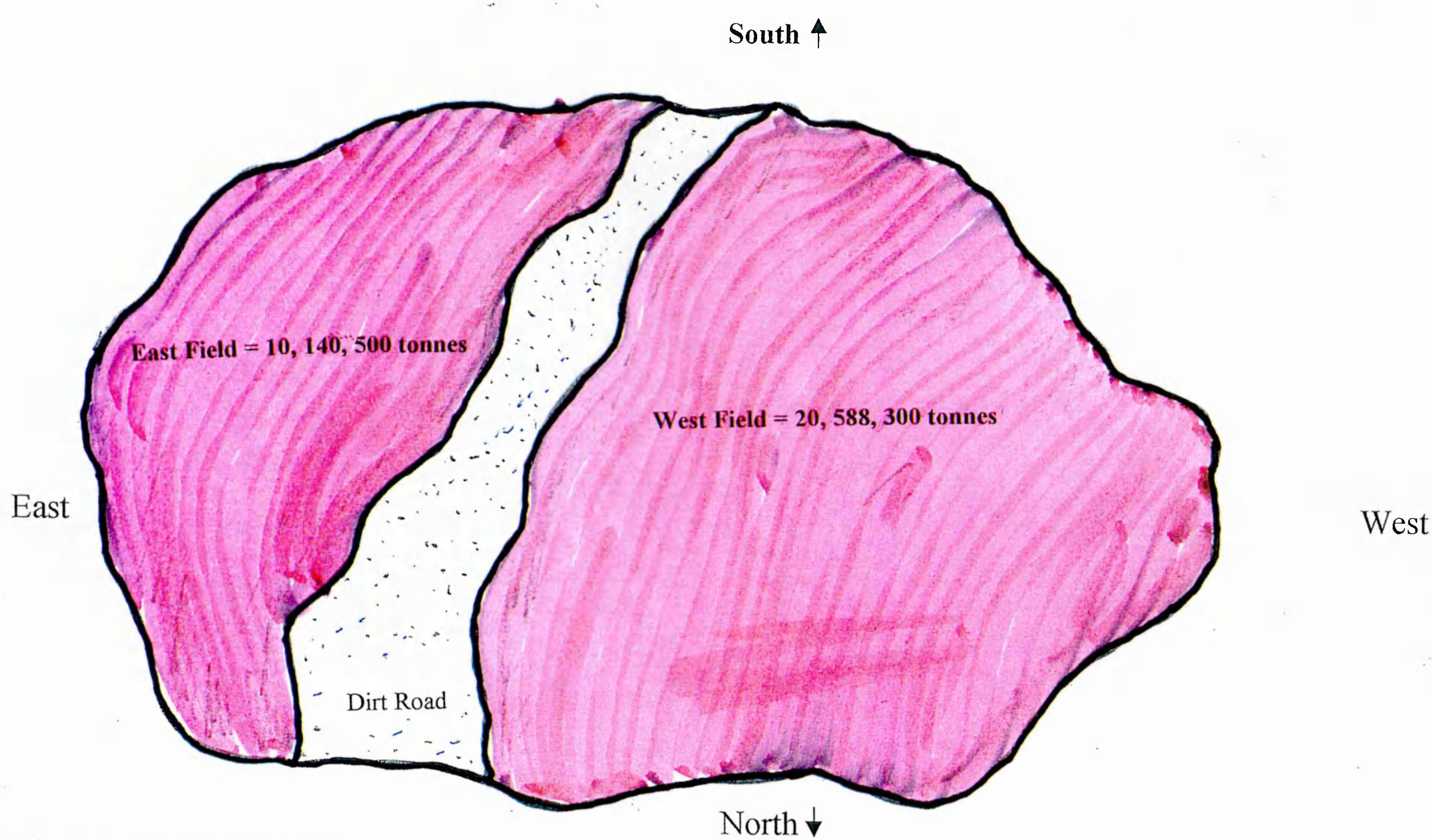


Figure 20 a. The East and the West fields.

7.3.6. Output of the quarry

The volume of exploitation of Massalliqun clay quarry in order to assure the planned cement production at the Darnah Cement Plant, will correspond to the above calculated demand with the following losses taken into account (Fig No. 21):

- exploitation losses **3%**
- transport losses **2%**
- technological losses **7%**

Total = **12%**

Figure 21. Losses of clay in transport

Table 11. Average of output of the Clay quarry

Item	Quantity of Clay / tonne.			
	hour	shift	day	year
1. Output	160	1,120	2,240	591,400
2. Transport	1552	1,087	2,123	573,700
3. Losses in the quarry	4.8	33	117	17,700

(After Libyan Industrial Research Centre Report, 1991)

Table 12. Maximum output of the quarry

Item	Quantity of Clay / tonne.			
	hour	shift	day	year
1. Output	184.2	1,290	2,580	680,960
2. Transport	178.7	1,251	2,502	660,530
3. Losses in the quarry	5.5	39	78	20,430

(After Libyan Industrial Research Centre Report, 1991)

For the maximum output, the necessary quantity of mining machines for clay were presumed.

The expected exploitation period will be:

$$\frac{\textbf{Total exploitation amount: } 30,728,800 \text{ t}}{\textbf{Output per annum: } 591,400 \text{ t}} \quad \boxed{= 52 \text{ years}}$$

- **West field - 35 years.**
- **East field - 17 years.**

7.3.7. Environmental Procedures and safety

Owing to the fact that the quarry is a deep open-pit with high perimeter walls it is surrounded, by a safety fence and warning signs to prevent accidents to local people. Drainage ditches have been dug arround the perimeter of the quarry to try and prevent any major ingress of surface water. Within the open-pit a dump area has been created to collect water from the quarry floor prior to it being pumped out and away from the site. These measures ensure a relatively dry quarry floor and benches to facilitate the extraction of limestone and clay.

Blasting is dangerous, not only for the people and machines within the quarry, but also for nomadic pastorlists in the area surrounding the quarry. The following conditions are therefore imposed on quarrying operations:

Maximum scattering zone:

Long shot-holes	**200 m.**
Short shot holes (small diameter)	**300 m.**

Dust zone during blasting: Maximum allowable radius of the dust zone from blasting and loading sites **300m.**

Seismic zone: Minimum range of seismic activity, which can affect buildings and their foundation, is **200 m.**

Blast zone: Blast zone is **550 m.**

(Darnah Cement Plant, 1988 & Libyan Industrial Research Centre, 1983, Trans.)

7.3.8. After-Use Quarries Reclamation

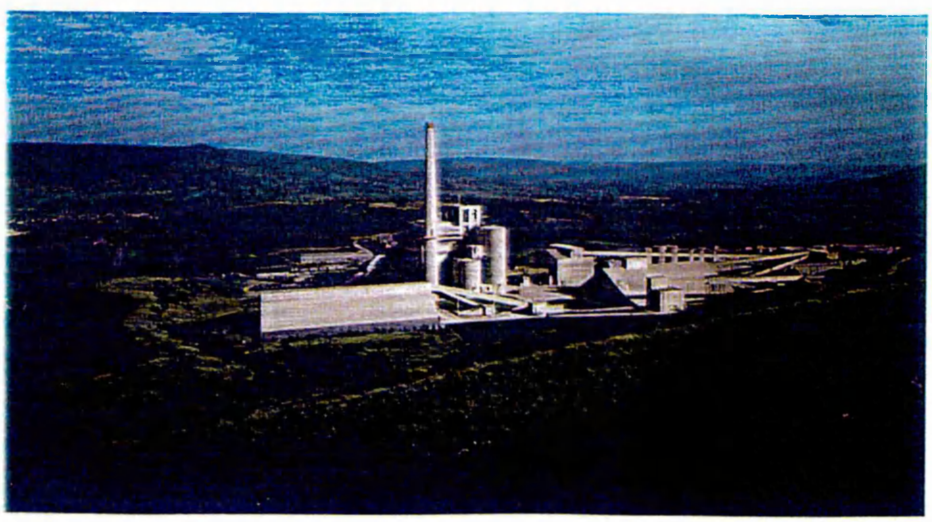
In that part of the quarry where extraction of limestone or clay has ended, plantations of trees are already being established by using the "pit-planting" technique. Holes are prepared in the quarry floor to a depth of 500mm and then filled with imported soils before the planting of citrus and fruit trees. Deeper holes and soils are prepared for Olive, Karob or Carob and other trees such as Oak. This planting progresses in relation to the rate of extraction of the limestone and clay, and does not wait until the final stage of limestone or clay exhaustion.

7.4. Case Study No. 2 Hope Cement Works, UK

Hope Cement Works was chosen as the UK case study because it is one of the larger cement producing plants in the UK and easily accessible to Sheffield. It demonstrates a long history of restoration techniques even though since 1951 it has been subjected to very stringent planning regulations imposed by the creation of the first National Park.

The quarry is fairly typical of those in the UK working Carboniferous Limestone. It does not compare with other limestone quarries working younger and shallower deposits. As a UK cement plant it does not illustrate some of the most up - to - date approaches to operation and methods of environmental impact reduction.

Figure 22. Aerial view of the Hope Site



Hope Cement Works lies in the heart of the Peak District National Park, in Derbyshire (Figure 22). This is an area renowned both for its outstanding natural beauty and extensive deposits of limestone and shale, the two main raw materials used in making cement. The Hope Cement Factory is one of Blue Circle's largest UK works, with capacity to make up to 1.3 million tonnes of cement per year. This is for distribution to customers throughout the north of England and north Wales.

Hope Cement Works started out as Earl's Cement Works in 1929. It was a wet processing cement works with two kilns. It steadily expanded and in the mid-thirties two more kilns were added. In 1942 due to its unique and sensitive location the decision was made, to develop an environmental protection plan (Jellico, 1993). The works already had four kilns and a similar number of mills. In 1952, one year after the Peak District became the first National Park in the UK, the fifth kiln was added. In the sixties it was decided to rebuild the works and switch to the more efficient dry process. Construction started in 1968 directly adjacent to the old works and in 1970 the new kilns were fired. Instead of five wet kilns with an hourly capacity of sixty-six tonnes altogether there were now two dry kilns each of eighty tonnes per hour capacity using the same amount of fuel.

Hope Works became part of the Association of Portland Cement Manufacturers (APCM), a conglomerate of major cement works throughout the UK. APCM was renamed Blue Circle Cement, which is today the core business part of Blue Circle Industries. This is a worldwide operating company with divisions in sanitary equipment, heating and heavy building materials. (www.bluecircle.2000 & Hope Cement Works, 1999)

7.4.1. Importance of Cement Industry

The cement industry produces 1,367.4 million tonnes (1994) of cement worldwide. This figure has been steadily growing in recent years, mainly due to technological progress in developing economies.

The UK Blue Circle Group contributed to the world production with 6.65 million tonnes, of the UK12.2 millions tonne contribution to the world (Interim Environment Report 2000 in www.defra.gov.uk/environment & www.bluecircle.co.uk)

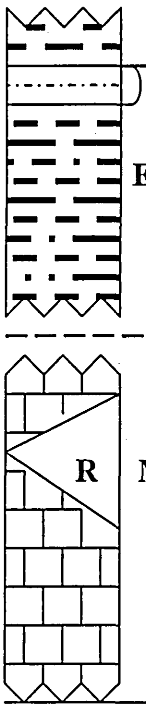
Since cement is one of the main components of concrete, it is used in nearly every building, be it a bridge or a brick-laid house. Roughly 60% percent of all cement produced goes into the production of concrete, the reminder being sold mainly in 25kg paper bags for small scale and domestic use. (www.bluecircle.com)

7.4.2. The Raw Materials for the Works

Limestone and shale, the two principal raw materials used for making cement at Hope, are quarried adjacent to the Works, the limestone and shales are from the Lower Carboniferous deposits of the area. The limestone is from the upper part of a thick deposit of bedded and reef limestones of the Monsal Dale Group while the shale is from the overlying Edale Shales formation (Figure 23).

Figure 23. Hope Cement Works showing the quarry benches

Figure 24. Sequence of strata quarried at Hope Cement Works



Edale Shales	**Millstone Grit Series**	**NAMURIAN**
Monsale Dale Group	**Carboniferous Limestone Series**	**DINANTIAN**

(Not to scale)

Limestone is quarried by blasting the rock loose with explosives. Each blast loosens some 10,000 tonnes of stone, enough to supply the works for around two and a half days.

Limestone requirement per year:

4000 tonne / day x 365 days = 1.460.000 tonne / year

Large mechanical diggers are used to load the limestone blocks into dumps-trucks, which carry them to the primary rock crusher. The blocks vary in size and weight ranging from 1.5 m wide to "pea-size", and from five tons to a few grams. The crusher is the first of three, which fragment the stone, reducing it to around 25 millimetres in size. The stone is taken from the quarry by a series of conveyor belts to the raw materials store at the works, over a kilometre away. The limestone provide the essential $CaCo_3$ for the cement making process.

Shale, a soft rock, is excavated without blasting, using mechanical diggers. The rock is crushed before being taken by conveyor to the raw materials store. The clay delivers the SiO_2, Al_2O_3, and Fe_2O_3 needed for the chemical process.

To achieve the chemical balance needed in cement, the two rocks are used in ratios of approximately 82% limestone to 18% shale. The ratio of limestone and shale is regularly adjusted to ensure consistent product quality.

To meet the demand of the cement plant some 10-15,000 tons per week of crushed stone is required. Due to the close positioning of the plant to the quarries the costs and environmental impacts of additional transportation are mostly reduced.

7.4.3. Process of Cement Making

After quarrying the raw material, the first stages in processing are

1) Crushing to a pebble size of up to approximately 30 mm in diameter;
2) Grinding them into a fine powder called raw meal. The mills revolve at high speed and steel balls inside them pulverise the stone into raw meal. From the mill, the raw meal is analysed before being pumped to blending silos.
3) After blending, the meal is again analysed before being stored in silos, which can hold about one week's use. Blending the various materials into the stream of raw material to feed the kiln with a constant chemical composition is the most important step to maintain consistency.

7.4.4. Environmental activities

The Hope Cement Works has been a leader in environmental management and site restoration for over fifty years. Hope's programme of phased landscaping for its operations, adopted in 1943, was one of the first for a UK industrial site. The design, originally developed by leading landscape architect Sir Geoffrey Jellicoe (1993), has evolved and is still in use today, where it is principally focused on the quarries. (Figure 25). (Hope Cement Works, 1999)

Figure 25. Jellicoe Brow: restored landscape

Around 2.5 million tonnes of limestone waste unsuitable for cement making has been contoured and landscaped to conceal the limestone quarry entrance; this feature has been aptly named 'Jellicoe Brow' on the topographic map.

An extensive tree-planting programme to screen the works and harmonise it with the local environment has backed the work at the limestone quarry. Over 69,800 trees have been planted between 1970-2000; some 10,000 more will be planted in the next five years.

Further landscaping has been undertaken to add leisure amenities to the site, worked out clay pits which once provided raw materials have been flooded to form lakes now used by local fishermen; a nine-hole golf course has also been developed with plans to add a second nine holes. (Figure No. 26, 27, 28) (Hope Cement Works, 1999)

Figure 26. New Golf course at Hope cement works.

Figure 27. Waste materials placed at the foot of the face and planted with vegetation

Figure 28. Restoration blast pile at Hope Quarry.

Blue Circle's current investment of £26 million in equipping the works for the new millennium reflects this commitment to environmental management. Over forty per cent of the money, £11 million, are being used for new equipment to further improve the work's environmental performance. This includes the introduction of highly efficient bag filters on the main kiln exhaust gases, the first time they have been used on kiln exhausts in the UK.

The Work's Environmental Management System (EMS) has been certificated to the ISO 14001 International Standard. This system ensures that the works meet exacting environmental standards and operates within limits in authorisation from the government regulator, the Environment Agency. It identifies and sets out procedures to manage the potential or actual effect/impacts the operation has on the local environment. These include:

- **Emission to air.**
- **Discharges to water.**
- **Waste management.**
- **Noise and vibration.**
- **Land management/visual impact.**
- **Energy consumption.**
- **Water use.**
- **Transport and distribution.**

(Blue Circle Environmental Policy, 2000 in www.bluecircle.com)

This approach is not currently applied to quarry operations in Libya.

7.5. Summary of environmental works by Sir Geoffrey Jellico 1943, until present-day: (After Jellicoe, 1993)

The Limestone Quarry.

The waste from the early phase of the quarry is to be placed on the lower benches, and thereafter to be returned and dumped inside the quarry in a position convenient to the operations in progress. Not to show above the edge of the quarry, and not to be easily visible through the mouth of the quarry.

The Quarry Platform Banks.

These to be roughly grassed. The only precedent lies in the grassing of railway embankment or colliery dumps. Experience with the latter shows that to be fully effective in the early stages it is necessary to provide adequate topsoil to a depth of at least 50mm, and wattles or some other device to prevent subsequent soil erosion. This process is elaborate, and it is recommend, as a test, that top soil be lightly spread over a small area and worked into the existing surface, and that grass be lightly sown on this. This may be adequate, since an appearance of green on new slopes is more important than that grass should be of good quality.

The Factory Precincts

A good deal of tidying up could take place, and local dumps could be concealed. Particular care should be taken at the exact junction of buildings and playing-fields. Experience in army camouflage has shown that one or two small temporary buildings awkwardly placed may become disproportionately conspicuous.

Playing-Fields

Additional trees may be added round the miniature golf course, if desirable. It is suggested that there should be concrete blocks forming a kind of landing stage between the playing-fields and lake; this to extend across the opening between the bleached limes. Further buildings in the landscape, such as a divingboard, could be in concrete, but should be gracefully designed. More substantial buildings, such as a boathouse, should be associated with trees.

Marsh Farm.

The surrounding edge should be planted with mixed hardwood as indicated, as soon as reasonably possible. The future positions of the wash mill to be fixed and planting to take place round this according to the drawings.

Tree Planting.

The waste areas will be approximately levelled with a bulldozer, or by other means, and, when necessary, drained by open-surface drainage. All new plants must be protected from rabbits, either individually, or as a wired-in area. The planting is to follow the accompanying guide, and there should be, in addition, low planting as necessary, to encourage bird-life.

Tree Nursery.

It is recommended that this be established forthwith.

Setting-Out

All setting-out may be approximate only, according to the drawings, except for the following:-

(*a*) All lines so indicated must be parallel to or at right angles to the buildings.
(*b*) The intersection between the two angles forming the one side of the boating lake and the playingfields must be reasonably opposite the centre line of the bowling pavilion.

(*c*) The dimensions described in the tree-planting notes should be reasonably adhered to.

(*d*) The curve of the quarry bank now being formed should be reasonably rounded in conformity with the neighbouring slopes of the hillside; the purpose is more to recreate the hillside than to make an artificial bank.

(*e*) The three tree lines at the quarry entrance are to be equidistant, one from another, parallel, and at approximate right angles to the factory buildings. The individual trees on the platform are to be set out on an approximate grid.

The effect of the works on outlined by Jellico (1943) is summarised in the following quotation:

"*The planting of trees and shrubs at Hope has been a continuous process since the inception of the original landscape plan. Linked with planting has gone careful ground shaping, and the constructive use of wastes, to provide screening where necessary, and to link new levels with existing ground.*

Nowhere has this been more important than in the banking leading up to the great limestone quarry.

Early planting concentrated upon the works area, and today the approach to the works itself, the railway line, and the south-western margins of the playing fields are linked by belts of mature trees: Norway maples, poplar, ash and mountain ash, wild cherry, and many others. These, under planted by such shrubs as dogwood, snowberry, guelder rose and the wild privet, for ground level screening, provided a country character right up to the reception retained as a link with the earliest days of the Works.

A considerable achievement has been the retention, unharmed, of large established trees throughout major extensions to the works, in close proximity to the new buildings. The lakes today are fringed with birch and willow, their northern shores closely wooded, with natural regeneration taking over from man's handiwork, with a more open planting on south-west. Meanwhile, as the designer envisaged, considerable bird life has come to the valley, and in particular to the lakes." (Jellicoe, 1993, p. 18)

Chapter 8. Discussion

8.1. Overview and evaluation

This study presents the results of a review of the role of environmental impact assessment within the planning processes that applied in Libya and the UK for the opening and extension of limestone quarries required for the cement manufacturing industries. Some of the approaches applied in the UK and elsewhere are evaluated in terms of their transferability to the situation in Libya. Modern approaches currently being used in the UK are examined to see how they may link closely to practices in Libya over the past Millenium.

The research does not cover the detail of ecological and other techniques of quarry restoration but reviews options for sympathetic after-use of the former quarries. Details of quarry restoration and reclamation are to be found in the writings of authors such as Buckley (Ed.) (1989), Gilbert and Anderson (1998) and Harris, Birch and Palmer (1996).

In all cases they refer to situations in the UK or Western Europe but do reveal principles, which are relevant and transferable to the situation in Libya. It is in detail where they would fail in the Libyan context due to variations in environmental parameters. The approaches advocated in the USA by the Society for Ecological Restoration and others would be more applicable to the North African scene (Jordan, Gilpin & Aber, 1987).

The current research provides a historical review of the cultural changes experienced in Libya and the ways in which those ancient peoples have exploited the abundant material resource of limestone over the centuries. Reflecting on the past history it brings the exploitation of the limestone and clays for the cement industry up to the present day including modern UK approaches and techniques that are being adapted for use in the Libyan industry.

Limestone, as a dimension stone, was extensively used in Libya for the construction of a range of buildings from the large civic and religious ones down to humble dwellings. The Berbers, Phoenicians, Greeks, Romans, Jewish, Islam and Arab civilisations have exploited local limestone for domestic buildings. Such exploitation has impacted on the local environment leaving large valley-side terraces and significant towns.

Earlier formed terraces have been subsequently been utilised by later peoples as protected sites from inclement weather conditions. Much of the information about this early period has been obtained from both Arab and non-Arab sources, in particular, was sites such as www.arabnet.com, www.libyaourhome.com, www.libyanet.com, www.libyana.com, and www.cia.com.

The techniques of limestone exploitation as demonstrated by the ancient civilisations have a relevance to the present day situation and so the current ideas can be adapted to fit in with past practices to resolve present-day problems. This approach will be revealed in greater detail later in the chapter.

To set the context of the cement industry and its impact upon the present environment in Libya it is important to describe aspects of the regional physiography. This is presented in Chapter 3 and clearly illustrates the diversity in landforms, soils, climate and vegetation of the region around Darnah. These factors are borne in mind when considering applying techniques for quarry restoration currently in vogue in the UK.

Approaches to planning for the opening of limestone quarries was very limited in Libya until the coming of the major western oil companies in the 1950's. Since that time oil companies, mining companies, university departments and other Libyan government organisations have emphasised the need for environmental impact assessments in relation to major industrial developments. It is in this context that further information concerning limestone quarrying and cement manufacturing is being actively sought through this study.

The presence of such organisations, as listed above, enabled an assessment to be made of all the country's natural geological resources. From this assessment the abundance of limestone and clay deposits triggered the expansion of cement manufacture but within the constraints of a developing planning infrastructure.

Information gathered from the Libyan Cement Company demonstrates the progress made in both limestone extraction, cement production but also in environmental impact amelioration. From this data the selection of the Darnah Cement Plant as made as the study site in Libya.

In contrast, the Hope Cement Works was selected as the UK example not because of its close comparability but it illustrated some of the best practices currently being employed in the restoration of the quarry and amelioration of the impact made by the quarries and plant upon the local environment. The Hope site has a long, well recorded history of restoration begun in 1943 long before the establishment of the National Park has imposed greater planning constrains upon the management and upon the operation of the plant.

Even so there are ideas and techniques currently in use at Hope which can be successfully transferred to Darnah such as the use of waste rock, the differential blasting and the establishment of vegetation through pit-planting and seed broadcasting.

From both case-study sites there are major difference but these are outweighed by the many similarities in approaches to the planning processes and the successful re-vegetation to ensure their value for appropriate after-uses respectively.

In Chapter 3 a background to quarrying and to the potential after-use of such sites is presented through the writings of experts such as Bradshaw & Chadwick (1980), Bradshaw (1987), Coppin & Bradshaw (1982), Davies (1991) and Gunn, Bailey & Gagen (1992). Together they present applicable and transferable ideas and procedures for the sympathetic restoration of former quarry sites to some appropriate after-use in order to reduce the impact upon the environment.

To emphasise the variations in the planning procedures currently practised in the UK and Libya detailed outlines are presented together with sample documentation. The major differences in the procedures include a "bottom-up" approach, in Libya, where the investor (Developer) seeks permissions from various agencies of Government before submitting the application for approval at ministerial level. No environmental impact assessment is required to be present by the 'investor' (Developer). In the UK the procedures are "top-down" where government departments prescribe the various stages. Under this system the Developer must adhere to the various stages, including the submission of an environmental impact assessment statement and an after-use proposal prior to lodging the application with the relevant "Minerals Planning Agency". In both cases, if conditions are met then permissions are granted. In both countries consultation with the local communities is facilitated. In Libya the decision-makers have government strategies and regulations to follow but above all they have to deal with the local tribes (the land owners) by explaining the consequent benefits from the proposed project and written guarantees for helping them to restore the site according to their wishes.

In the UK local opinion is considered during the application when environmental impact may only be resolved through the payment of compensation. Further more, the ultimate consent may be tightly controlled through the application of a number of conditions, all of which have to be adhered to otherwise the permission may be withdrawn.

Environmental Impact Assessment has developed as a distinct element of the planning process in the western countries. A review of its development is presented in chapter 4 of this study. It is now considered and applied on an international level and has been adopted in North African countries of Algeria, Egypt, Libya, Morocco and Tunisia. Of these countries, Libya was held back in its development of environmental policies due to the sanctions imposed by the UN.

Prior to the sanctions some limited application of EIA was implemented in and around the oil installations but less so for other extractive industries.

Since 1999, when the UN sanctions were suspended, the Libyan government has embarked upon a major programme of developing environmental procedures which it is hoped will improve the well-being of its people and enhance the quality of its environment both urban and rural.

The application of EIA in each country will vary, in detail, due to variations in population density and the needs of the people and the general physiogeophy of the countryside. However, there is a growing desire, in Libya, to implement greater protection for the environment yet to allow the quality of life of people to rise.

Throughout the Millennium the various peoples who have occupied Libya have always found ways of making beneficial use of former limestone quarries. Initially these were worked by hand and therefore were of small size (2-4 ha) compared to the very large (149 ha) modern quarries worked by large machines.

In general, the small, early quarries followed the deposit of the limestone from the outcrop along the sides of the valleys (wadis) leaving benches surrounded by stepped faces. Depending upon aspect, these sites would offer protection from some of the adverse weather conditions such as winds from the south and west or shade from the sun.

As a consequence the sites were used for domestic development plus the growing of herbs and fruits and the keeping of some livestock.

In the modern large quarries, techniques of restoration practised in the UK may have a role to play if adapted to the local conditions. Pit-planting of quarry floors to establish trees and shrubs is already taking place as past of progressive restoration schemes. The treatment of high bench faces in the UK has used the technique of "differential blasting" to create "dale-side land-forms" in a bid to reduce the visual impact. Modification of this technique could be used to modify quarry faces in Libya. To date it has not been used. However, following past practice by earlier peoples the larger quarries can be adapted to provide sites for small farming enterprises (See Figure No. 13, p. 75).

The bench faces would be terraced and pit-planted with fruit trees such as lemon, orange, grapefruit and figs while the quarry edge would be pit-planted with olive, karob or Carob and probably more hardy species of pine and cypress to form wind breaks.

The broader terrace can be shaded with a vine pergola under which various horticultural crops could be grown. Similarly the quarry floor can be pit-planted and imported soil used to create patches for horticultural crops. In all cases, the sites within the boundaries of the quarry would be sheltered and protected from the adverse weather conditions.

This style of restoration, an up date on much earlier practices, is a unique proposal when compared with the general pattern of restoration which is illustrated in the data assembled in Appendix 3. (p. 181) and summarised in Table 4 (p.88).

The significant points drawn from these data are:

- More quarries, in Libya, are left to colonise naturally over a long period of time compared to the UK.
- More of the Libyan quarries have been used for agricultural and horticultural enterprises compared to the UK.
- More of the UK quarries have been restored to nature conservation and amenity use compared to Libya.
- More quarry sites in Libya have been used for commercial enterprises compared to the UK where legislation over "closure" may prevent such uses.
- While flooding may be practised in the UK it is less practised in Libya due to high water loss by evaporation. The building of cisterns in quarries may be the answer.

Consideration of sympathetic after-use of quarries in Libya is worthy of serious note. Techniques currently employed in the UK could be modified and applied in partnership with long-practised methods by the indigenous population throughout history

Chapter 9. Conclusion

As a basis for this study a considerable body of information has been accessed and evaluated. This includes a major translation of important, informative and relevant documents from Arabic into English. This literature was assessed and reviewed in the context of the cultural and political framework of Libya itself, and also in terms of the context of western environmental policies and strategies. A particular focus of the research was the assessment of relevant approaches to the issues of mining, quarrying and processing used in the UK for planning operations and extensions of limestone quarries. The planning policy framework involved was important to this assessment. An evaluation of these approaches taken in the UK was made in order to assess their potential for transfer to the quarrying and cement industries in Libya.

Similarly, analysis of a sample of the various options for after-use of former limestone quarries in the UK, demonstrated a wide diversity of end-uses, and indeed of the levers and drivers for particular restoration and after-use schemes. Some of these end-uses (such as for agriculture, commercial development, nature conservation and amenity use) have aspects which with relatively minor modifications, would be applicable to the Libyan situation.

Whilst many of the smaller quarries in Libya have already been adapted to a beneficial end-use, the larger quarries have a long period of exploitation before them. Even so, some like Darnah are undergoing progressive restoration in the exhausted parts of the quarry while production is still advancing in other parts. When fully exhausted then schemes like that illustrated in Figure 13 can be fully implemented. Many of the methodologies applied in the UK could also be used for the Libyan scenario. There are however some important constraints and these will be noted later.

Following an evaluation of the planning processes in both countries, and in particular a consideration of the role of Environmental Impact Assessment in that process, it is clear that Libya has some considerable way to go in terms of environmental protection in resources exploitation.

The process of environmental planning, EIA and environmental management systems, was begun by the arrival of major western oil companies. These multi-national organisations brought with them a culture of environmental responsibility and of response to relevant national and international environmental legislation and agreements or controls. However, whilst this is to be welcomed in principle, its impact has been very limited so far. There now needs to be substantial and rapid progress to incorporate these procedures and cultures into mainstream industrial operations in Libya. In particular this research has identified the need to make rapid progress to implement appropriate policies for limestone extraction and cement manufacture. The operation of such systems in the UK industry can provide a template for such legislative systems. This is because even though the current planning procedures start from such different positions, they basically achieve the same goals in permitting or controlling the development and exploitation process.

Cultural differences and developments over a long period of time have markedly influenced the systems adopted in the two countries. However, there are aspects of the systems employed in the UK and other western countries that can be used but which will have to be modified to bring them into sympathy with the political and cultural requirements of Libya. This will be necessary in order for them to be successfully implemented.

In particular, environmental conditions relating to topography, climate and ecology impose further constraints on the application of restoration techniques. These therefore have to be carefully adapted to fit in with the local conditions. It has been demonstrated that this can be done and will permit the successful and beneficial use of former limestone quarries once they are exhausted. One major conclusion from the work is that the cultural history and the environmental conditions of the country have a major impact on both the potential after-use of former industrial sites such as quarries, and also on local people's attitudes to them. For quarries in Libya, and unlike the situation (usually at least in the UK), the former limestone quarry is seen as a positive resource. Without the twin constraints of high human population density and with large areas of arid land available, combining with searing Saharan winds, the development of a quarry in Libya is not generally contentious. Furthermore, at the termination of its industrial life it provides the community with a positive asset. This has been the way in Libya since back in the pre-Roman period.

Clearly the situation for limestone transportation and for processing and manufacture of cement, the situation is very different. Here the planning procedures, environmental management systems and people's attitudes will have much more in common with those in the West. There are major opportunities to modify and incorporate appropriate measures into the Libyan system.

Much can be learned from the legacy of human occupation of the Country, by many different cultures over the Millennia. This relates to how such peoples have exploited the natural resources yet have also adapted to the environmental conditions. If such lessons can be applied to the modern quarrying context, then successful and sustainable exploitation can be achieved. This will most easily come about by the process already described. Essentially it is suggested that best practice guidance currently operating in the UK (for all the industrial stages discussed) should be modified and carefully tailored to the Libyan system. It is not necessary to remove the present system; and indeed this would not work (for the social and historical reasons noted), but the relevant procedures could be taken, modified and integrated into the Libyan structures. Part of this would be in providing the necessary legislative and structural support, and importantly providing a system of training and awareness rising for key personnel at all levels. A key element probably essential for successful adoption and implementation of these measures will be the degree of 'ownership' of the ideas and systems by the Libyan operators themselves. If the systems appear to be imposed or even copied from the West, then they are far less likely to succeed.

For the Libyan regime it is recommend that the establishment of appropriate links to scientists and technical specialists in the UK would be very beneficial. This would provide help for the environment and also for the future of the Libyan people affected by minerals exploitation and subsequent processing. The UK's experts are amongst the leaders in the modern world in environmental procedure restoration and quarry after-uses. Expertise which has developed over time since Sir Geoffrey Jellico in 1943, and the work of individuals, such as Professor Tony Bradshaw at Liverpool University throughout the late twentieth century.

Finally, relevant Environmental Policies need to be developed further in Libya. This will be to encourage positive relations with the rest of the world, to take a lead in North Africa and in southern Mediterranean environmental issues. Importantly it will also mean that Libya will comply more fully with international policies and obligations. In this way, not only will Libya meet its global responsibilities but also it can be seen as a leading and influential player in encouraging and determining appropriate environmental policies and procedures throughout the emerging economies of the world.

By developing restoration practices that are fully embedded in the context of Libyan traditions will be a significant demonstration of the potential of this approach. This could be through the adoption of valley-side restoration for domestic use. Techniques to restore the remaining faces of the former quarries to more environmentally valuable end-uses, could provide modest examples of how this approach might operate.

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Appendix No.1

The Libyan Contract Clauses

CLAUSE 1

"Who is the investor?"

The investor might be himself in person or one of his official clients who is eligible to be the representative of the investor.

CLAUSE 2

" The quarry area and its characteristics."

According to the Act No. 2 - 1972 regarding quarries and mines, and under this contract conditions, " The investor awarded the right to extract and transfer the material from the quarry No. ....
with its measures and characteristics to the place of consumption."
The quarry area (The investment objective) is determined, and confirmed by the quarries inspector, in consultation with the investor, is as shown on the attached plan. This enables the installation of site marker flags in conformity with the investor declaration on form No. 5 - 71, (As dictated in Act No. 2 - 1971).

CLAUSE 3

" The rent value and the term of the contract."

The term of this contract: ....Years.
Start date: ....to............................. .
Annual rent: ....Dinar.

The investor must pay the first year in advance.
Receipt No.: ....   Date: ....

Bank: ....

The rent for subsequent years will be paid in advance in the beginning of each year.

The investor has the right to reassess the annual rent value after every five years period, in accordance with articles No. 38, 39, (Act No. 2 - 1971).

CLAUSE 4

"Insurances."

Before signing the contract:

The investor pays: ....(As mentioned on the beginning).

This is in accordance with the executive list of payments made at the out set of the quarry operation. The insurance paid will be refunded at the end of the contract time, provided, that all the conditions indicated in the contract have been implemented.

No interest is payable on these insurances, and the ministry (1st party) has the right to confiscate the entire or some of these insurances (or part) to cover any type of damages resulting from any infringements made by the investor to any single clause of the contract terms. As well as this, if these insurances are unable to cover all the damages, then the ministry have the absolute right to cut the amount of money they require as a fine from any insurances belonging to the investor.

CLAUSE 5

" Taxation."

The investor has to pay money in cash to the ministry within one month in advance for the six months taxation period, in accordance with the taxation categories which are indicated in the implementation list of article No. 37, from Act No. 2 - 1971, by account: ....M. SQ

from: ....material, that extracted from the quarry.

If the investor does extends operations beyond the permitted site boundaries, then the taxation sum will be double. If the violation is repeated, then the fine will increase four fold.

CLAUSE 6

" Forbidden extraction of materials from mines and quarries."

It is compulsory for the investor to avoid extracting any other material from the quarry except the permitted material: ....
This is indicated in the second clause of the contract, unless the contract is for extracting sand, which will normally be mixed with gravel.

CLAUSE 7

" The contract renewal."

When the contract expiry date is approached, and the investor has performed all of the obligations that are required in the contract then the investor is free to walk away, otherwise the investor is wishing to renew the contract, then he must inform the Ministry about the possible renewal within not less than six months before contract expiry date. If the investor has fulfilled those requirements, then the contract may be extended for another term, not to exceed the first term with the possibility for the third extension not to exceed 15 years in total for the quarry near to the borders of cities or towns. By the renewal time, prices, in addition to the environmental impact expenses, will be under the same rental and taxation conditions, and for a period not to exceed 60 years for the distant quarries.

CLAUSE 8

" The replacement."

It is possible for the investor to exchange the original site on condition that it is not to exceed more than six months from the beginning of the contract or the operations. The new site must be close to the previous one not far than 1km, under the same conditions as in article No. 40 from Act No. 2 - 1971.

CLAUSE 9

" The contract contravention and the right of the cancellation."

The Ministry has the right to cancel the contract for the following reasons:

1- If the investor is unable to pay the annual rent or the periodical taxation within one month of receiving the official reminder letter.

2- If the permitted materials for extension are exhausted before the end of the contract term, or if the operational waste is dumped on land not being rented by the investor, and beyond the quarry boundary.

3- If the Government needs the site for the public interests, special utilities or for military operation. For any one of the obvious reasons, the contract will be cancelled and the investor will refund the remainder of the rent. The investor must be awarded notification of at least 30 days before moving.

4- If the investor has violated the operational conditions, as they are shown on the operations list, and the investor has refused to eliminate the violations within 15 day from the date of receiving the official warning letter.

5- If the quarry operations are ceased for a continuous period of 90 days.

6- If there is verification that the quarry site contains any kind of archaeological heritage, and the National Heritage Administration decided that the operation must cease in order to conserve the national heritage. The investor is required to obey the order and refund the rest of the rental.

CLAUSE 10

" Determine the quarry area."

The investor is committed to keeping all quarry boundary markers at its borders during the operational term. The investor is also required to erect those markers in accordance with the contract requirements. Thus if the investor breaks the contract clauses, then he will encounter multiple fines and penalties, possibly up to approaching five fold of the taxation sum.

CLAUSE 11

" National Heritage."

All ruin remains (such as statuaries, tressure, etc) found in the course of works, will be the property of the Government. The investor is required to report every single find to the Ministry representative. In handing material over to the Ministry, the investor is required to treat the finds very carefully, even before receiving instructions in regard of them.

CLAUSE 12

" Operation conditions."

It is compulsory that, the investor must start the operations at the quarry site immediately after signing the contract. They must be committed by the operation rules and decrees for the quarry concerning to guard against identified hazard. In particular there must be steps taken to prevent any hazards affecting others, for example, such as the land community.

CLAUSE 13

" The legal responsibilities for the others."

The investor is responsible for every detriment which may hit others, (people - companies - organisations, etc.), resulting from the quarry operation, and if the court finds against the company then the investor is requested to pay the compensation as a fine, and the investor must obey the judgement.

CLAUSE 14

" Sub-let the quarry to the others."

The agreement must be done between the investor, as the 1st party, and the ministry, as the 2nd party, to allow the 1st party to lease the quarry to another investor, in accordance with the conditions which follow:

1- The investor has agreed with the ministry and the contract decrees their dues in full, such as a rental, taxation, and insurances on time.

2- The new sub-let contract must include a frank and obvious declaration by the new investor indicated that they will follow and obey all decrees and conditions stated in the contract with all the relative modifications and additions.

3- The sub-let contract must be under the quarrying and the mining laws.

CLAUSE 15

" The land's ownership under the government disposal."

No body nor organisation has the right to construe any clause of the contract for the purpose of possessing the land which is the investment subject, except for government disposal of the entire area where the site is located, that disposal will be for a private public works or for military purposes. The investor is required to prevent others using the site or the used quarry land to build any type of construction on it.

CLAUSE 16

" The judicial competences (specialisations)."

Every judicial dispute occurring between the government and the investor with regard to interpretation of any clause of the contract or related to it, the judgement will be before the Libyan law. The investor is required to produce a well-known address by the 1st party and the government, also, if the investor has moved to a new address then it must be known by the 1st party and the government.

CLAUSE 17

" Accounting archives and bookkeeping."

**The investor is required to introduce a bookkeeping accounting archive as well as the important papers which are definitely necessary to implement the contract in accordance with the Act No. 2 - 1971, and, account for the due taxation.
Also, the investor is required to send a statement for every six month period, showing the extracted amount of material from the quarry and its sale price, and a list of the quarry's labour, amount and type of explosives used and the remainder still in the investor's storage.**

CLAUSE 18

" Observance of principles and instructions."

**The investor must be compliant with all of the principles and instructions which are periodically issued by the ministry regarding explosive's storage, the appropriate time to use them, as well as, the quantities which are allowed to be used each time, together with the methods of transportation.
The investor must take into consideration the quarry face and ground level (benching), as required according to the clauses in Act No. 2 - 1971, and in addition, to follow issued instructions regarding, hazards, labour health, property damage, resulting from the quarry operation.**

The instructions must be received by official letter (delivered by hand), informing the investor regarding his responsibilties for instruction and implementation, therefore, there is no exemption of any damage compensation resulting from the quarry operation.

CLAUSE 19

"The ministry representative co-operation."

The ministry representative(each in his / her own specialised subject field or area) has the absolute right to enter the quarry site to investigate the operations and the works systems, as well as the labour rights, and the environmental safety procedures. The investor and the labour are required to provide the representative with all information they request without suspending the quarry operations.

CLAUSE 20

" Financial settlements."

All the contract statements regarding the financial commitments between the 1st party and the 2nd party are valid after the revoking of the contract at the end of the term or for any another reason till the final settlement between the two parties is concluded.

CLAUSE 21

" The movables and the extracts situation at the contract expiry"

At the end of the contract, reference to the term end or renewing or cancellation, the investor is committed to the 1st party to obey the terms of the contract by ceasing the works and evacuating the quarry without need for any warning procedures. Evacuation will be at the expiry date or the cancellation, which must not exceed a period of 15 days from the cancellation date. Beyond this 15 days extension, all movables left in the quarry will become the property of the

government without any payment or compensation. If the investor wants to transfer the accumulated extracted material, then the 1st party will allow him to do that within the extra period of 15 days time, in accordance with Article No. 42, from Act No. 2 - 1971.

CLAUSE 22

" Handing over the quarry."

At the contract expiry adate or for any other reason for cancellation, the investor must hand over the quarry to the ministry representative without warning, otherwise, the ministry will occupy the quarry by administrating the law.

CLAUSE 23

" The investor's rights to obtain accessory contracts to be able to invest in the quarry."

The government is not bound by the contract to offer any kind of services or facilities such as routes, drainage streams, water, electricity, etc, for the quarry and its investment interest. At the end of the contract all projects established by the investor, at the quarry by government agreement and permission, will be regarded as of public benefit and will therefore be the property of the government. The investor should not prevent others using them, especially the new neighbourhood investors. The investor is able to obtain an accessory contract to extend railway or overhead electric cables, etc, in accordance with Act No. 2 - 1971, within the contract conditions.

CLAUSE 24

" Giving up the contract."

The investor is able to give up the contract at any time by informing the ministry within a period of one month notice for a one year contract, and period of six

months notice for a five years or more contract, after the ministry agreement. In this case the investor has no obligation to refund the rest of the annual rent.

CLAUSE 25

" The validity of the contract."

The validity of the contract starts from the date of commencement of the works as mentioned in the contract conditions in accordance with Act No. 2 - 1971, and its implementation list.

CLAUSE 26

" Equipment required."

The 2nd party (investor) is required by commitment to provide a 4x4 car for the 1st party free of payment to ensure the ministry representatives and environmental members can undertake their weekly and monthly visits.

The investor signature: ....

Name: ....

Date: ....

2. The conditions of the UK Council's official contract:

These conditions attach to form TCP3 dated 25th September 1989 in respect of an application for planning permission to extend the existing limestone quarry at Bolsover Moor, Bolsover - Code No : BOL/888/414 (File No : 5.614.3)

Clarification:

2- The development approved by this permission including the reclamation of areas outside the extended extraction area shall be carried out in accordance with the details furnished in the application documents and supporting information, plans and drawings, except as may be agreed in writing by the Mineral Planning Authority.

Duration:

3- All of the operations authorised or required by this permission shall be completed not later than 15 years from the date of this permission.

Hours of Operation:

4- Except as may otherwise be agreed in writing by Mineral Planning Authority no operations authorised or required by this permission are permitted except between the following times:

Quarry Operation

Including overburden and soil removal but excluding drilling operations:

Mondays to Fridays 6 am - 6 pm

Saturdays 6 am - 1 pm

Drilling

Mondays to Fridays 7 am - 6 pm

Saturdays 7 am - 1 pm

Blasting

Mondays to Fridays 8 am - 4 pm

Saturdays 8 am - 1 pm

Servicing, maintenance and testing of plant

Including other similar work of an essential nature.

Mondays to Fridays 6 am - 6 pm

Saturdays 6 am - 4 pm

Sundays 7 am - 1 pm

None of the above operations shall be carried out on Bank Holidays or National Holidays.

Soil removal and storage:

5- All soil movements shall be carried out when the soil is sufficiently dry and friable to avoid unnecessary damage to its structure by smearing and compaction.

6- All topsoil, subsoil and overburden shall be stripped and stored separately in locations to be agreed in writing by the Mineral Planning Authority in consultation with the Ministry of Agriculture, Fisheries and Food prior to the commencement of any soil stripping from the approved extension area.

7- Topsoil and subsoil storage areas shall be constructed with only the minimum amount of compaction necessary to ensure stability and shall not be traversed by heavy machinery except during stocking and removal for respreading during the reclamation of the site.

8- Topsoil and subsoil mounds shall be seeded with suitable grass mixture following their formation and shall be kept free from weeds until such time as they are removed for use in the reclamation of the site.

9- All topsoil and subsoil shall be retained on site for its subsequent use in the reclamation of the site. After each phase of stripping and formation of storage mounds the quantities shall be measured and recorded on a plan, a copy of which shall be submitted to the Mineral Planning Authority within three months of the formation of such mounds.

Environmental Protection:

10- No blasting operations shall take place which will result in ground vibrations with a peak particle velocity greater than 12 mm per second in any plane at the nearest existing residential property to such operations.

11- Prior to the commencement of the extraction of limestone from the extraction area approved by this permission a scheme for the monitoring of blasting including the location of monitoring points and equipment to be used shall be submitted to the Mineral Planning Authority for approval. All monitoring shall then be implemented in accordance with the details approved by the Mineral Planning Authority, or with 0such amendment as may subsequently be agreed in writing with the Mineral Planning Authority. The operators shall on request furnish the Mineral Planning Authority with particulars of the measurements recorded.

12- Notwithstanding the generality of condition 10 above the blasting operations shall be carried out in such a way that in respect of any period of 16 consecutive weeks the peak particle velocity shall not exceed 6 mm per second in more than 90% of all blasts carried out during that period as recorded at the location specified or agreed under Condition 11.

13- Prior to the commencement of the extraction of limestone from the extraction area approved by this permission details of the methods employed to minimise air overpressure from blasting operations shall be submitted to the Mineral Planning Authority for approval. Blasting operations shall then be implemented in accordance with the details approved by the Mineral Planning Authority, or with such amendments as may subsequently be agreed in writing with the Mineral Planning Authority.

14- No secondary blasting shall take place except where unavoidable for reasons of safety.

<u>Dust Control</u>:

15- Efficient dust collections shall be fitted and maintained on rock drills at all times of operation.

16- The operation of the quarry shall be carried out in such a manner as to minimise the operation and emission of dust.

<u>Noise Control</u>:

17- All vehicles and plant or machinery used on the site shall be fitted with effective silences.

<u>Prevention of mud on highways</u>:

18- All reasonable steps shall be taken to prevent mud and other dirt being carried from the site into the public highway.

<u>Plant, Machinery & Buildings</u>:

19- Notwithstanding the provision of part 19 of Schedule 2 of the Town and Country Planning General Development Order 1988 no fixed buildings, plant or

machinery, or structure in the nature of plant or machinery shall be erected in the quarry outside the area shown hatched on plan BOL 888/414/1 (i.e. processing plant area) except for the relocation and use of the mobile crusher.

Screening:

20- Notwithstanding the requirements of Condition 6 the screening bund on the north eastern boundary of the site shall be extended to its full and final form in the first phase of any overburden and soil stripping in final form in accordance with the submitted Drawing No B48/18, except as may otherwise be agreed in writing by the Mineral Planning Authority.

21- The tree screen on the south western boundary on the site shown on submitted Drawing No B48/18 shall be implemented in two phases :

1- The tree screen adjacent to Phase 2 of the proposed operations shall be implemented within 12 months of the date of this permission.

2- The tree screen adjacent to Phase 3 of the proposed operations shall be implemented within 5 years of this permission or 12 months prior to soil and overburden stripping operations in Phase 3 whichever is sooner, except as may be agreed in writing by the Mineral Planning Authority.

Aftercare:

22- An Agriculture Aftercare Scheme requiring that such steps as may be necessary to bring the land to the required standard for use for agriculture shall be submitted for the consideration of Mineral Planning Authority in consultation with the Ministry of Agriculture, Fisheries and Food within 12 months from the date of this permission or within such other period or periods as may have previously been agreed in writing by the Mineral Planning Authority.

23- The submitted scheme shall specify the steps to be taken and state the five year period(s) during which they are to be taken. The steps shall include planting, cultivating, fertilising, watering, drainage and otherwise treating the land.

24- The Aftercare of the site shall be carried out in accordance with the Aftercare Scheme as approved or modified by the Mineral Planning Authority.

25- Where the Mineral Planning Authority, after consultation with the Ministry of Agriculture, Fisheries and Food, agree in writing with the operator that there shall be lesser steps or a different timing between steps, the Aftercare Scheme shall be carried out in accordance with that agreement.

Reclamation:

26- The detailed reclamation of the site shall be carried out in accordance with a scheme which shall have been submitted to the Mineral Planning Authority for approval within 12 months of the date of this permission, or writing by the Mineral Planning Authority. The scheme shall, amongst other matters include details of the following :-

a) Quarry floor treatment.
b) Quarry face treatment.
c) Timed phasing of reclamation scheme.

Appendix No. 2

The Libyan Plants List

Scientific Name	Local Name	Growth Nature	Flowering	Geographic Distribution	Environment
AIZOACEAE:					
Aizoon hispanicum. L.	Ghasool	annual	Jan-Jun	widely distribution	Rocky and sandy environ-ment.
ALLIACEAE:					
Allium erdelii. Zucc	Krath Kalb	perennial bulb	Mar-Apr	southern middle east	Libyan coastline
Allium longanum. Pamp	Kapel	perennial bulb	Mar-Apr	endemic	
Allium oriental. Boiss	Kapel	perennial bulb	Mar-Apr	middle east	Al Akhdar-Naffusa
Allium sub-hirsutum. L.	Laoss	perennial bulb	Feb-May	Mediterranean-Ethiopia	semi-dry environment
AMARANTHACEAE:					
Amaranthus albus. L.		annual	Mar-May	Middle east-Europe-North Africa-Australia.	
Amaranthus graecizanus. L. ssp. Silvestris		annual	Oct-Dec	North Africa, South East Asia	
AMARYLLIDEAE:					
Narcissus tazeta. L.	Nargiss	perennial bulb	Nov-Jan	Mediterranean	Al Jabel Al Akhdar regio
Pancratium maritimum. L.	Nwar Kalb	perennial bulb	Jun-Jul	Mediterranean	
ANACARDIACEAE:					
Pistacia lentiscus. L.	Battoom	perennial shrub	Mar-Apr	Mediterranean-Iranian	Al Akhdar valleys and over 150 m altitude regions
Rhus tripartita. Grande. (Rhamnus tripartita ucria.)	Jdarri	perennial shrub	Oct-Jan	east and south Mediterranean region.	
ARACYNACEAE:					
Nerium oleandrlinn.	Defla	perennial shrub	Mar-Aug	Mediterranean	moisture valleys and wat streams.
ARACEAE:					

Arisarum vulgare. Targ. Arum arisarum.	Rens	perennial nodule	Mar- Nov	north Africa and southern Europe.	Libyan coastline and Al-Akhdar mountain.
Arum cyrenaicum. Hruby. Arum italicum auct.	Rensh	perennial bulb	Mar-Apr	indigenous in Cyrenaica	
ASCLEPIADEAE:					
Caraluma europaea (Guss)N. E. Br. (Stapelia europaea. Guss.) (Apteranthes gussoniana. Mikan.)	Daghmose	perennial-Juisy leaves	Mar-Nov	west Mediterranean	Calcareous soils and rock
Periploca angustifolia. Labill. (P. Laevigata auctt.)	Hallab	perennial shrub	Mar-May	Mediterranean	Dry rocky regions an valleys slops.
BORAGINEAE:					
Anchusa hybrida. Ten. (Anchusa undulata auct) (A. Amplexicaulis. Sm)	Harsha	biennial	Mar-May	Mediterranean and extend to Portugal.	Al Jabel Al Akhdar
Barago officinalis. L.	Remeh	annual-biennial	Mar-May	Mediterranean and west African coast.	Al Jabel Al Akhdar
Cynoglossum cheirifolium. L. (C. arduanum. Coss.)	Audshamess	biennial	Feb-May	Mediterranean	Kouf valley ....
Echium angustifolium. Mill (Echium sericeum. Vahl.)	Earkshamess	perennial	Jan-Mar	Mediterranean	sandy soils environment
Echium setesum. Vahl.		annual	Mar-May	Libya-Egypt-Syria	rocky slopes and routes sides

Lithodora hispidula.(sibth&Sm) Grseb. (litho-spermum hispidulum.)	Jardah	perennial shrub	Mar	Mediterranean	rocky slopes
BRASSICACEAE:					
Nonea viviani. DC.	Thawelaniz	annual	Mar-Apr	endemic	Al Jabel Al Akhdar to Benghazi
Alyssum minus. L. Rothm. (Clypeola minor. L.)		annual	Feb-Mar	Mediterranean	Al Jabel Al Akhdar
Biscutella didyma. L. Biscutella var columneae.	Haflesh Hara	annual	Feb-Mar	Mediterranean & Iran	Al Jabel Al Akhdar
Cakile aegyptica. L. Willd. (Isatis aegyptica. L. (C. maritima. Scop.	Shakarah Hara	annual & biennial	Mar-Apr	Mediterranean	Coastline sands
Capsella bursa-pastoris. Medik. (Thalaspi bursa-pastoris. L.	Krat	annual & biennial	Feb-Mar	Mediterranean	Cold regions
Carrichtera annua. L. DC.	Khashinah	annual	Feb-Mar	Mediterranean & Iran	
Cornringia orientalis. L. Andrez		annual	Mar-Apr	Mediterranean & Iran	fertile land
Didesmus aegyptius. L. Desf	Leasless	annual	Feb-May	Europe & Middle-east	grazing land
Diplotaxis virgata. Cav. DC.	Celtam	annual	Feb-Mar	East-south Mediterranean	Al Jabel Al Akhdar
Matthiola longipetala. Vent. DC		annual	Mar-Apr	Mediterranean & Iran	
Matthiola tricuspidata. R.Br. (Cheiranthus tricuspidatus. L. ssp.		annual	Jan-Feb	North Africa	Al Jabel Al Akhdar
Neslia apiculata. Fish		annual	Mar-Apr	South Europe & North Africa	Northern mountains &

					fields
Rha-Phanus raphamistrum. L.	Fagalbarri	annual	Feb-Mar	Europe - North Africa & West Asia.	fertile land
Sinapis alba. L. (S. alba var melanosperma. Alef.)	Khardal	long annual	Feb-Mar	Widely distribution	Al Jabel Al Akhdar
Sinapis arvensis. L.		annual	Feb-Apr	Widely distribution	fertile fields in Al Akhdar
CAESALPINIACEAE:					
Ceratonia siliqua. L.	Kharob	tree	Sep-Nov	Mediterranean	Maquis at the low altitude
CAMPANULACEAE:					
Comanula erinus. L.		annual	Feb-Mar	Mediterranean & Iran	Valleys slopes
CAPRIFOLIACEAE:					
Lonicera etrusca. Santi. (L. Cyrenaica. Viv.)	Jemmatfatat	perennial creepy	May-Jun	Asian & Mediterranean	
Lonicera nummularifolia. Jaup &Spach.		perennial scrub	Apr-Jun	Mediterranean & Iran	
Viburnum tinus. L.	Mernakh	perennial scrub & tree	Mar	Mediterranean	Al Jabel Al Akhdar
CARYOPHYLLACEAE:					
Petrorhagia illyrica. Ard. Ball & Heywood.		perennial	Feb-Jun	Mediterranean & Polkan	
Silene cyrenaica. Maire & Weiller.	Thaffernaja	annual	Feb-Apr	indigenous in Libya	Al Jabel Al Akhdar
Silene nocturna. L.		annual	Mar-Jun	Mediterranean & Arabia	Libyan coastline
Silene succulenta. Forsk. (S. Corsica D.C.)	Naffel	perennial under scrub	Feb-Jul	Mediterranean	Sand banks
Silene vulgaria. Garcke.	Zakal	perennial	Mar-Apr	Widely distribution	Fields margins
Spergularia marina. L. Gariseb.		annual & rarely	Jun-Dec	Mediterranean & Asian	Libyan coastline

		perennial			
(Arenaria rubra. L.)					
Vaccaria pyramidata. Medik.	Foolalarab	annual	Feb-Mar	Widely distribution	Abandoned & fertile field
(Saponaria vaccaria. L.)					
CHENOPODIACEAE:					
Arthrocnemum macrostachyum. Mories.	Belbal-jemal	perennial scrub	May-Sep	Mediterranean shores	
Atriplex coriacea. Forsk.	Kataf	perennial scrub	Aug-Nov	North Africa	
Atriplex halimus. L.		perennial scrub	Jan-Oct	Southern-east Mediterranean	Sandy saline areas on Libyan coastline.
Cornulaca monocantha. Del.	Swadah	perennial under scrub	Oct-Nov	North Africa & Iran	Sahara regions
Halocnemum strbilacium. Pall. M. Bieb.		perennial & Juicy	May-Sep	Mediterranean & western Asia	Saline coastline
Hammada scoparia. Pomel. Iljin.	Ramath	perennial scrub	Oct-Nov	Mediterranean & Iran	Rocky environ & low salinity sandy regions.
(Haloxylon articulatum. Moq. Bunge.)					
Salsola schwein-lurthii.	Sarref	perennial scrub	Sep-Oct	Arabian Sahara	Sandy soils in dry regions
Suaeda pruinosa. Lange.	Shefshaf	perennial under scrub	Feb-Apr	Spain-Malta-North Africa	
(S. Fructicosa. Var brevifolia. Moq.)					
CISTACEAE:					
Cistus incanus. L.	Berbish ahmer	perennial scrub	Mar	Mediterranean	Al Jabel Al Akhdar
(C. Polymorphus. Willk.)					

Cistus parviflorus. Lam.	Berbish asfar	perennial under scrub	Feb-Apr	East-Mediterranean	Maquis
(C. Cymosus. Duna ex. DC.)					
Cistus salvifolius. L.	Trrash abyz	perennial under scrub	Mar-Apr	Mediterranean & Iran	Maquis
CIstus stipulatus. Forsk.	Berbish abyz-Rekak	perennial under scrub	Apr-Aug	East Mediterranean & Arabia Sahara	Maquis & sandy steppe
(Helianthemum stipulatum.) Forsk. C. chr.					
Fumana arabica. L. Spach.	Merghadah	perennial under scrub	Mar-Apr	Mediterranean & Iran	Al Jabel Al Akhdar
Fumana laevipes. Spach.	Merghadah	perennial under scrub & stunted growth	Mar	Southern Europe & North Africa	
(Cistus laevipes. L.)					
Fumana scoparia. Pomel.		perennial under scrub	Mar	Mediterranean	Al Jabel Al Akhdar
Fumana thymifolia. L. Spach et welb.		Under scrub & stunted growth	Mar	Mediterranean	Al Jabel Al Akhdar
(Cistus thymifolius. L.)					
Helianthemum aegyptiacum. Miller.	Ghamha, Hagela	annual	Mar-Apr	Mediterranean & Iran	Sandy environment
Helianthmum cinereum. cav. Pers.		Short under scrub	Mar-Apr	North Africa & southern Europe	AlJabel Al Akhdar
Helianthmum lavandulifolium. Miller.		perennial	May-Jun	Europe & Mediterranean	Dry environment
Helianthmum ledifolium. L. Mill.	Zare-elfakrona	annual	Feb-Mar	Southern Europe, Africa & east Mediterranean	Dry environment
COMPOSITAE:					
Anthemis pseudocotula. Boiss.	Ek-howan-	annual	Mar-Apr	Mediterranean, Iranian &	Abandoned fields

	abyz			desert	
Artemesia herba-alba. Asso.	Sheih	perennial scrub	Sep-Dec	western Iran & Mediterranean	Semi-dry environment
Atractylis cancellata. L.	Gernezah, Mass	annual	Mar-May	Mediterranean	
Atractylis serrata. Pomel.	Gernezah	annual & biennial	Mar-May	Endemic in North Africa	Rocky pastures
Atractylisa sp.		annual			
Bellis sylvestris. Cyrill.	Hothan, Earik	perennial	Mar-Dec	Mediterranean & Iran	Mediterranean steppe
Calendula arvensis. L.	Ek-howan	annual	Apr-Dec	Mediterranean & Iran	Abandoned fields
Calendula tripterocarpa. Rupere.	Afferah	annual	Mar-Apr	Arabia deserts	Sands & rocky sands in desert
Carduus argentatus. L.		annual	Apr-May	East-Mediterranean	Maquis routes margins
Carduus australis. L.	Raketa, Hanther	annual	Mar-May	Mediterranean	Routes margins
(C. Pycnocephalus. L.)					
Carlina involucrata. Auct.	Raketa	perennial	Jun-Sep	European & Mediterranean	
Centaurea calcitrapa. L.	Shok-hommar	biennial		Mediterranean	
Centaurea pumilia. L.	Akash	perennial	Mar-Apr	East-Mediterranean	sand dunes
Chrysanthemum coronarium. L.	Kahwan	annual	Mar-Jun	Mediterranean	Abandoned fields
Cichorium intybus. L.	Lahiat Alshike	perennial	May-Jun	Mediterranean, Europe & Iran	Fertile fields
Cichorium spinosum. L.		perennial	May-Jun	West Mediterranean	Sand dunes
Clandanthus arabicus. L. Cass.		annual		Mediterranean	Fertile fields
Conyza bovei. DC.		perennial	Mar-Sep	Sudan & Desert	Routes margins
Crepis bulbosa. L. Tausch.		perennial	Mar-Jun	Mediterranean	Sandy soils on the coastline
(Aethiorhiza bulbosa. L. Cass.)					steppe
Crepis pulchra. L. ssp. typica. Bab.		herbs	Mar-May	Europe & Mediterranean	
Crepis vesicaria. L. ssp. taraxifolia. (Thuill) Thell.	Hothan	annual	Apr-May	Europe & Mediterranean	
Cynara cyrenaica. Mair et weill.	Emrare	perennial	Apr-May	Endemic	Maquis
Echinops spinosissimus. Terra.	Llbad	perennial	Jun-Jul	South Mediterranean & Iran	
Evax umbellata. Caertn.		annual	Mar-Apr	Mediterranean	Dry environment
Filago desertrum. Pamel.	Taiem Alarnab	annual	Feb-Apr	Arabian deserts & Iran	

Filago germanica. L. Var. Canescens. Germ & Gord.		annual	Mar-Apr	Mediterranean	Maquis
Geropogon hybridum. Sch. Bip. (G. glaber. L.)	Abogerebah	annual	Apr-May	Mediterranean & Iran	
Hedypnois cretica. L. Willd. Hedypnois cretica ssp. Rhagadioloides. L. Schmidt.	Aumghwimish	annual	Mar-Apr	Mediterranean	Abandoned fields
Helichrysum sicalum. Boiss.	Mseka	perennial	Mar-Apr	Middle-east	
Helichrysum stoechas. L. DC	Mseka	perennial	Mar-Apr	West-Mediterranean	
Hypochoeris achyrophorus. L.	Hothan	annual	Apr-May	Mediterranean	
Inula graveolens. L. Desf.		annual	Aug-Sep	Mediterranean	Abandoned fields
Lactuca harmemiana. Aschers.	Albenatwadi	perennial		Endemic	
Lactuca tuberosa. Jacq.		Perennial & biennial	Apr-May	Middle-east & Western Iran	Maquis
Matricaria recutita. L. (M. chamomilla. L.)	Kiehawan	annual	Apr-May	Mediterranean	
Notobasis syriaca. L. Cass.	Rkita	annual	Mar-May	Mediterranean	Routes margins
Onopordon alexandrinum. Boiss.	Bayroof	Perennial & biennial	Mar-May	Arabian desert & Iran	Rocky sandy steppe
Onopordon espinosa. L. Coss	Bayroof	annual	Apr-May	Libya & Tunisia	
Pallenis spinosa. L. Cass.	Shokahmmar	perennial & biennial	Apr-Jun	Mediterranean	Abandoned fields & maquis
Phagnalon rupestre. L. DC.	Taiemarnab	perennial	Mar-Jun	Mediterranean	Rocky environment
Picris aculeata. Vahl.		annual	Mar-May	North Africa & Malta	
Picris cupuligera. Dur. Wallp.		annual	Mar-May	North Africa	Dry environment
Ptilostemon chamaepeuce. L. Less.	Taiemnasser	perennial under scrub	Apr-May	Middle-east	Rocky slopes
Reichardia tingitana. L. Roth.		annual	Feb-Apr	Iran & Arabian desert	Sahara environment
Rhagadiolus edulis. Gaertn.	Ghrean-Naija	annual	Feb-Apr	Mediterranean	Fertile fields
Scorzonera alexandrina. Boiss. (Seratula cichoracea. L. DC.) (Ssp. mucronata. Desf. Jahardies & Mair	Bogerebah	perennial		Mediterranean	
Scorzonera cornopifolia. Desf.		perennial bulb		Endemic	

Scorzonera mollis. M. Bieb.		perennial	Apr-May	Mediterranean	
Scorzonera undulata. Vahl.		perennial tuberous	Apr-May	Middle-east	Dry steppe
Senecio flavus. Decne. Sch. Bip		annual	Mar-Apr	Arabian desert	Sandy desert
Senecio glaucus. L. (Senecio desfontainei druce.)		annual	Feb-Apr	Mediterranean	Sahara environment
Senecio leucanthe-mifolius. Poiret.		annual	Mar-Apr	Mediterranean	Sandy areas & routes margins
Senecio ver-nalis. waldst & Kit.		annual	May-Nov	Middle-east & Iran	Fertile & abandoned field
Sonchus oleraceus. L.		annual	Mar-Oct	Europe, Mediterranean & Iran	Routes margins & fertile fields
Taraxacum microcephalum. Pomel.		perennial	Mar-May	Endemic in North Africa	Steppe
Thrincia tripolitana. Sch. Bip.	Gothan-Arab	perennial	Apr-May	Endemic	Dry environment
Thrincia tuberosa. L. DC.		perennial	May-Dec	Mediterranean	Maquis
Tragopogon porrifolius. L.	Safe-Ghorab	biennial		Mediterranean	
Tragopogon porrifolius. ssp. cupani. Rechrdson. T.B.K.					
Tragopogon porrifolius. ssp. macrocophlus Pomel. Baot.					
Urospermum picroides. L. Schmidt.		annual	Mar-Apr	Europe & Mediterranean	Abandoned fields & route margins
CONVOLVULACEAE:					
Convolvulus althaeoides. L.	Allagh	perennial	Mar-Jun	Mediterranean	In the Calcareous Sandy soils at an abandoned fields
Convolvulus humilis. Jacq.		perennial	Mar-May	Mediterranean	Calcareous & silt soils
Convolvulus maireanus. Pamp.		perennial	Mar	Endemic	Calcareous & silt soils
Convolvulus oleifolius. Desf.		perennial under scrub	Feb-Jun	Mediterranean	Calcareous shore slopes b 300m altitude.
Convolvulus siculus. L.	Rajiah	annual	Mar-Jun	Mediterranean	Calcareous & sandy soils
Convolvulus tricolor. L.		annual	Mar-May	Southern Mediterranean	

Cressa cretica. L.		perennial	Oct-Nov	Mediterranean & Iran	Sandy moisture soils at th fertile fields
CRASSULACEAE:					
Sedum caespitosm. Cav. DC.		annual	Mar-Apr	Mediterranean	Sandy & Rocky environment
Sedum sempervivioides. Fish.		perennial	Jun-Jul	Middle-east	Rocks & Rocky soils
Sedum sp.					
Umbilicus intermedus. Boiss.	Thauael naja	perennial bulb	Mar-Jun	Middle-east	Walls & Rocks cracks
CUCURBITACEAE:					
Citrullus colocynthis. L. Schrad.	Hanthal	perennial	May-Aug	Arabian desert	Sandy soils & Dry environment
CUPRESSACEAE:					
Cupressus sempervirens. L.	Sarrow-Ariz	tree	Mar-May	Middle-east	Calcareous soils at Pine plantations.
Juniperus phoenicea. L.	Arar-Shaira	tree	Mar-Jun	Mediterranean	The most common plant a Al- Koaf national park.
CUSCUTACEAE:					
Cuscuta epithymum. Murry. (C. europaea var epithymum. L.)		parasitical - annual	Mar-Jun	Mediterranean	
Cuscuta palaestina. Boiss.	Harera-malweah	parasitical - annual	Apr-Jun	Middle-east	
CYERACEAE:					
Carex divisa. Huds. (Carex sp.)	Saad	perennial	Mar-Apr	Atlantic & Mediterranean	Widely distribution
Cyprius laevigatus. L.		perennial	Apr-May	Europe & Mediterranean	Sandy coastline
Eleocharis palustris. L. Roemer.		perennial	Apr-Jul	Europe & Mediterranean	Swamps environment

S-ciripus lacustris. L.	Borbaet	perennial	Mar-May	Widely distribution	Swamps environment
Scirpus littoralis. Schrad.	Saad	perennial	Apr-Jun		Swamps margin
DIOSCORACEAE:					
Tamus communis. L.	Allek	perennial	Dec-May	Europe & Mediterranean	Under shadowy trees
DIPSACACEAE:					
Pterocephalus papposus. L. Coulter.		annual	May-Aug	Middle-east	Dry-Mediterranean environment
Scabiosa arenaria. Forskal. (S. rhizantha Viv.)	Namelah	annual	Mar-May	Middle-east	
EPHEDRACEAE:					
Ephedra alata. Decne.	Shdedah	short scrub	Mar-May	Desert	Rocky desert
Ephedra altissima. Desf.		scrub	Mar-Apr	Semi-Endemic in North Africa	Forests
Ephedra camylopoda. C.A.Mey. (E. fragilis. Desk sub sp.		short scrub	Aug-Oct	Middle-east	Hills & Rocky land
ERICACEAE:					
Arbutus pavarii. Pamp. (A. unedo auct.)	Chemari	perennial scrub	Oct-Apr	Mediterranean	Mixed maquis
Erica multiflora. L.	Hamra	perennial scrub	May-Dec	North & South Mediterranean	Al Jabal Al Akdar & Calcareous rocks
EUPHORBIACEAE:					
Euphorbia barrelieri. Savi.		perennial	Mar-Apr	North Mediterranean	
Euphorbia calcyptrata. Coss et Dur.		annual		Endemic	Desert
Euphorbia characias. L.		perennial	Mar-Apr	West Mediterranean	
Euphorbia dendroides. L.	Halablab	short scrub	Mar-Apr	Mediterranean	Mediterranean slopes

Euphorbia Falcata. L.		annual	Mar-Aug	Mediterranean & Iran	Fields
Euphorbia helioscopia. L.		annual	Jan-May	Mediterranean & Iran	Fields & Routes margins
Euphorbia peplis. L.		annual	Dec-May	Atlantic & Mediterranean	Fields & Routes margins
Euphorbia segetalis. L.		perennial	Mar-Apr	Atlantic	Calcareous rocks
Euphorbia thamnoides. Boiss.		perennial under scrub	Jan-Apr	Middle-east	Stony soils
Euphorbia terracina. L.		perennial	Mar-Aug	Mediterranean	Sandy soils
Mercurialis annua. L.		annual	May-Dec	Mediterranean & Iran	Abandoned fields & route margins
FABACEAE:					
Anthylis tetraphella. L.	Shakwit alraie	annual	Feb-Apr	Mediterranean	Mostly distributed on coasts
(Physanthyllis tetraphella. L._ Boiss.)					
Anthyllis vulneraria. L.		perennial & annual	Feb-Apr	West Mediterranean	Valleys margins
Anthyllis vulneraria. L. ssp. Mura.Lindle.					
Astragalus carpinus. L. ssp.Laniger.Desf.		perennial	All year	Middle-east & Iran	
Astragalus epiglottis. L.		annual	Mar-Apr	Mediterranean	
Astragalus hamosus. L.		annual	Mar-May	Mediterranean & Iran	Abandoned fields
Astragalus tribuloides. Del.		annual	Mar-Apr	Middle-east & Iran	Abandoned fields
Calicotome villosa. Link. (Spartium villosum poir)	Ghandol	perennial scrub	Mar-Apr	Mediterranean	Maquis
Coronilla scorpioides. L. Koch.	Ghreanah	annual	Feb-Apr	Mediterranean & Iran & Europe	Fertile fields
(Ornithopus scorpioides. L.)					
Crotalaria microphylla. Vahl.		perennial	Sep-Nov	Desert	
Dorycnium hirsutum. L. Ser.		perennial under scrub	Mar-Apr	Mediterranean	Al Koaf valley & Al Akhdar

(Lotus hirsutus. L.)					valleys margins
Genista acanthoclada. DC.	Lahyat alsheik	perennial scrub	Mar-May	North Africa	
Hippocrepis unisiliquosa. L.		annual	Feb-Mar	Mediterranean	Deteriorating lands
Hymenocarpos circinatus. L. Savi.		annual	Mar-Apr	Mediterranean & Iran	Herbaceous covering land
Lathyrus aphaca. L.		annual	Jan-Mar	Mediterranean	
(L. polyanthus. Boiss.)					
Lathyrus digitatus. M.B. Fiorp.		perennial	Mar-May	Middle-east	Maquis & Shadowy areas
Lathyrus saxatilis. Vent. Vis.		annual	Mar-Apr	Mediterranean	Al Jabal Al Akhdar
Lotus creticus. L.		perennial	Mar-Oct	Mediterranean	Al Jabal Al Akhdar
Lotus ornithopodioides. L.	Ghreanah	annual	Mar-Apr	Mediterranean	Al Jabal Al Akhdar
Medicago coronata. L. Bart.		annual	Mar-Apr	Mediterranean	
(M. polymarpha var minima. L.)					
Medicago murex. Wild.		annual	Mar-Apr	Mediterranean	
Medicago orbicularis. L. Bart.		annual	Mar-Apr	Mediterranean & Iran	Fertile fields & routes margin
(M. polymorpha. L. Var orbicularis. L.)					
Medicago polymorpha. L.		annual	Feb-May	Mediterranean	Common in Al Akhdar close by fertile fields.
(M. nigra. Krock.)					
(M. hispida. Gaerth.)					
Medicago tornata. L. Mill.	Nafel	annual	Feb-May	Mediterranean	
Melilotus officienalis. L. Pall.		annual & biennial	Mar-May	Europe & Asia (as a fodder)	Fertile fields
Melilotus sulcatus. Desf.		annual	Mar-May	Mediterranean	
(M. longifolia. Ten.)					
Onobrychis caput galli. L. Lam.		annual	Mar-Apr	Mediterranean	Maquis at over 400m altitude
(Hedysarum caput galli. L.)					
Onobrychis crista-galli. Lam.	Thafer kalba	annual	Mar-May	Arabian Desert, extend to North Africa & Western Iran	
(Hedysarum caput galli var crista-galli. L.)					

Ononis alopecu-roides. L.		annual	Apr-May	Mediterranean	
Ononis hispida. Desf.		perennial under scrub	Feb-Jun	Mediterranean	
Ononis natrix. L.	Krashit-ejdi	perennial under scrub	Jan-Apr	Mediterranean	
(O. ramosissima. Desf.)					
Ononis natrix. L. var. Stenopophylla.Boiss.		perennial under scrub	Jan-Apr	Mediterranean	
Ononis viscosa. L.	Krashit-ejdi	annual	Mar-May	Mediterranean	Eastern Libya & Al Koaf Park
(O. breviflora. DC.)					
Psoralea bituminosa. L.		perennial	Mar-Jun	Mediterranean	Libyan coastline
(P. palestina. Gauan.)					
(Aspalthium bituminosum. Medik.)					
Retama raetam. Forsk. Webb.	Rtam	perennial scrub	Feb-Apr	Mediterranean coasts, Iran & Arabian desert	Dry environment
Scorpiurus muricatus. L.		annual	Mar-Apr	Mediterranean	Valleys margin
(S. sub-villosus. L.)					
Scorpiurus muricatus. L.var sulcatus. L. Fiori.		annual	Mar-Apr	Mediterranean	
Spartium junceum. L.	Aleagh	perennial scrub	Mar-Jun	Mediterranean	Al Jabal Al Akhdar
Tetragonolobus purpureus. Moench.		annual	Feb-Apr	Mediterranean extend to Ukraine	
(Lotus tetragonolobus. L.)					
(L. purpureus var palestinus. Post.)					
Trifolium arvense. L.		annual	Feb-Apr	Mediterranean & Iran	Routes margin
(T. longisetum. Boiss.)					
Trifolium campestre. Schreb.		annual	Feb-Apr	Mediterranean & Europe	
Trifolium dasyurum. C. Presl.		annual	Feb-Apr	Middle-east	
(T. formosum. D' vrre)					
Trifolium purpureum. Lois.		annual	Feb-Apr	Mediterranean & Iran	Widely distribution

Trifolium scabrum. L.		annual	Jan-Apr	Mediterranean & Iran	
Trifolium squamosum. L. (T. maritimum. Del et Bird.)		annual	Feb-Apr	Mediterranean & Europe	Along side coastline
Trifolium stellatum. L.	Daghees	annual	Mar-Apr	Mediterranean & Iran	Al Jabal Al Akhdar
Trifolium tomentosum. L.		annual	Feb-Apr	Mediterranean, Europe & Siberia	Widespread in Libya
Vicia sativa. L.	Gelban Gharinah	annual creepy	Jan-Apr	Mediterranean & Europe	Widely distribution
Vicia sativa. L. var amphicarpa. Boiss.		annual creepy	Jan-Apr	Mediterranean & Europe	Widely distribution
Vicia tetrasperma. L. Moench ssp. pubescers. DC. Asch et Gr.		annual creepy	Feb-Apr	Europe & North Africa	Al koaf valley & Al Akhdar
FAGACEAE:					
Quercus coccifera. L	Ballot	perennial green scrub	Mar-Apr	Mediterranean	Al Jabal Al Akhdar
GENTIANACCAE:					
Centaurium pulchellum. Swartz Druce.		annual	Jun-Dec	Europe & Asia (north & middle)	
GERANIACEAE:					
Erodium abrorescens. Desf Willd.	Mraad	perennial	Mar-Apr	Mediterranean & Iran	
Erodium bryoniaefolium. Boiss.	Ashbet Mrwaad	annual & rarely perennial	Apr-May	East Arabian desert	Desert & Sandy stone areas
Erodium gruinum. L. Herit. (Geranium gruinum L.)	Aboshefah	annual & biennial	Feb-Apr	Western Southern Mediterranean & Iran.	Coastline sandy soils
Erodium hirtum. Forsk Willd.	Garentalgazal	perennial	Jun-May	Western Southern Mediterranean	Northern mountain of Libya
Erodium malacoides. L. L'Her.	Raghmah	annual & biennial	Feb-Apr	Mediterranean & from Kokaz	Coastline hills of north

				to Pakistan	Libya
Erodium touchyanum. Delile. (E. muliebre. Durieu.)		annual & biennial	Mar-Jun	Arabian & Iranian desert	North east of Libya. Al Akhdar
Geranium dissectum. L.	Ashbet Mrwaad	annual & biennial	Feb-Apr	Mediterranean & Middle of Asia	
Geranium molle. L.	Al Mrwaad Ahmr	annual	Mar-Apr	Mediterranean & Europe	
Geranium robertianum. L.	Ashbet Mrwaad	annual & biennial	Mar-Jun	Mediterranean & Europe	Maquis
Geranium tuberosum. L.		perennial	Feb-May	Mediterranean	Al Akhdar & Nafossa mountain
GLOBULARIACEAE:					
Globularia alypum. Linn.	Zareghah	perennial under scrub	Oct-Apr	Mediterranean	Hills & coastline environment
Globularia arabica. Jaub & sp.		perennial scrub	Apr-May	Southern Mediterranean	Calcareous-rocky environment
GRAMINEAE:					
Aegilops ovata. L.	Ghamhat Hajal	annual	Jun	Mediterranean & Iran	Dry-rocky environment
Aegilops ventricosa. Tausch.	Ghameha	annual		Western Mediterranean	
Aeluropus laevis. Trin.	Nagelat Bahar	perennial	Apr-Oct	Mediterranean	Dry-saline soils
Agropyron junceum. L. P. B. (Var. Sartorii. Boiss.)	Samah	perennial creepy	Apr-May	Mediterranean & Atlantic	Coastline sandy dunes
Ammophila arenaria. L. Link.	Berbeat-Deass	perennial	Apr-May	Northern of Libya	Sandy coastline
Andropogon distachyus. L. (Pollinia distachya. L. Spreng.)	Borokba	perennial	Apr-May	Mediterranean & Desert	Rocky environment
Aristida caerulescens. Desf.	Sysem-Nassi	perennial grass	May-Jun	Mediterranean & Iran	Dry steppe & Semi-desert
Arrhenatherum elatius. L. Mert.		perennial grass	Apr-May	Europe & Asia	Maquis

Avena sterilis. L.	Khafoor	perennial	Mar-May	Mediterranean	Oak forest & Calcareous soils
Brachypodium distachyum. L. Beauv. (Trachynia distachya. L. Link.)	Shiereah	annual	Apr-May	Mediterranean	Rocky dry hills
Briza maxima. L.		annual	Apr-May	Mediterranean	Grassy lands
Bromus croctus.		perennial		North Africa & Western Asia	Calcareous soils
Bromus hordeaceus. L.		perennial	Mar-May	Europe & Asia	Steppe & Forests
Bromus lanceolatus. Roth.	Ghamhat aradah	annual	Apr-Jun	Mediterranean	Grassy slopes
Bromus mardritensis. L.		annual	Mar-Apr	Mediterranean	Dry hills slopes
Bromus rubens. L.	Thail althalab	annual	Feb-Apr	Mediterranean	Dry calcareous gypsy hill
Catapodium loliaceum. Huds Link.	Shiereah	annual	May-Jun	Mediterranean	Moisture & shadow areas
Crithopsis deliliana. Schult Rozhev.	Boshtert	annual	Mar-May	Middle-east & Libya	Dry grassy lands
Cynodon dactylon. L. Pers.	Nagile	perennial	Mar-Nov	Mediterranean	Moisture environment
Dactylis glomerata. L.	Nagilah	perennial	May-Jul	Mediterranean & Europe	Rocky hills
Echinaria capitata. L. Desf.	naskeah	annual	Mar-May	Mediterranean & Atlantic	Low forest environment
Elytrichia canitata. L. Nevsh.		perennial		Europe	Coastline sandy dunes
Castridium ventricosum. Schinz.		annual	Apr-Jun	Europe	Disused land & routes margin
Caudinia fragilis. Beauve.	Sammah	annual	May-Jul	Mediterranean	Fertile field & routes margin
Heleochloa alonecurides. Host. (Phalaris geniculatas. Sbith & Sm.)		annual	Jul-Sep	Mediterranean	Waste land environment
Hordeum bulbosum. L.	Sheireah	perennial bulb	May-Aug	Mediterranean	Oak forests
Hyparrhenia herta. L. Stapf. (Andropogon hirtus. L.)		perennial	Mar-Jun	Mediterranean & Iran	Rocky hills & Dry calcareous Soils.
Koeleria phleoides. Vill. Pers.	Borwyis	annual	Mar-May	Widely distribution	Grassy steppe
Lagurus ovatus. L.	Theyl-elnaijah	annual	Apr-Jun	Mediterranean	Sandy lands
Lepturus incurvatus. L. Trin.	Sammah	annual	Feb-May	Widely distribution	Sandy lands & Fertile

					fields
Lolium rigidum. Gaud.	Sammah-Smma	annual	Apr-Jul	Mediterranean	Moisture hilly environment
Melica minuta. L.		perennial	Apr-Aug	Mediterranean	Scrubs environment
Oryzopsis coerulescens. Desf. Hack.		perennial grass	Apr-May	Mediterranean	Coastline environment
Oryzopsis miliacea. L. Bentham. Hooke.	Aborokbah	perennial	May-Jul	Mediterranean	Forestry environment
Phalaris brachystachys. Link.		annual	Mar-May	Mediterranean	Harmful grass at fields
Phalaris canariensis. L.	Berbeat	annual	May	Atlantic & Mediterranean	Fields environment
Phalaris coerulescens. Desf. (P. tuberosa. L.)		perennial grass	Mar-May	Western Mediterranean	Maquis & Fertile fields
Phalaris minor. Retz.	Aborass	annual	Mar-May	Mediterranean	Maquis & Fertile fields
Phragmitis australis. (cav) Trin et steud.		perennial	Jul-Oct	Moderated areas in the world	
Poa annua. L.		annual	Feb-Apr	Pandemic	Moisture environment
Poa bulbosa. L.	Gubba	perennial bulb	Mar-Jun	Atlantic & Mediterranean	Forest & Steppe environment
Poa sinaica. Steud.		perennial grass	Feb-Apr	Middle-east	Semi-arid environment
Sporobalus arenarius.(Goun) Duval-Jouv.	Najial-shytani	perennial grass	Jun-Oct	Mediterranean	Sand bank environment
Stipa barbata. Desf.	Bohemma	perennial grass	May-Jun	Middle-west	Arid rocky slopes
Stipa pennata. L.	Najilah	perennial grass	Aug-Sep	Mediterranean & Iran	Mountain tips
Stipa tortilis. Desf. (S. capensis. Thumb)	Bohemma	annual	Mar-Apr	Mediterranean	Arid steppe
Trisetaria cavanillesii. Trin. Maire	Kazbel-alkot	annual	Apr	Mediterranean & Iran	Rocky steppe
Trisetaria lineare. Forsk.		annual	Mar-Apr	Mediterranean & Iran	Sandy environment
HYPECOACEAE:					
Hypecom aequilobium. Viv.		annual	Mar-Apr	Egypt & Libya (Semi-endemic)	

HYPERICACEAE:					
Hypericum aegyptiacum. L.	Blekah-Boghralo	perennial short scrub		Middle-east	
Hypericum empetrifolium. Willd.	Blekah-Lbenah	perennial scrub	Feb-May	Middle-east	Maquis
ILLECEBRACEAE:					
Gymnocarpus decander. Frosk.	Gared-Teshash	perennial under scrub	Feb-May	Asia & Middle-east	Valleys land & Calcareous hills
(G. fruticosum. Pers.)					
Paronychia argentea. Lam.	Ashbat Arnab	perennial grass	Jan-Jun	Mediterranean & South east of Asia.	Sandy and rocky environment at Al Akhdar coastline.
(Illecebrum paronychia. Linn.) (I. argenteum. Pourr.) (P.hispanica. D.C.)					
IRIDACEAE:					
Gladiolus segetum. Ker-Gawl.	Safe halof or Safe ghorab	perennial bulb	Mar-Apr	Mediterranean & Iran	Fertile fields in Al Akhdar
Iris sisyrinchium. L. (Moraea sisyrinchium. Ker Gawl.)	Khytah safe Gh	perennial bulb	Feb-Apr	Mediterranean & Iran	Hills & arid environment
Romulea linaresii. Parb.	Gharshood	perennial grass	Feb-Apr	Europe & Turkey	Mountain environment.
JUNCACEAE:					
Juncus acutus. L.	Deas-Smmar	perennial	Feb-Mar	Mediterranean & Iran	Al Akhdar & Derna coastline
LABIATAE:					
Ballota psudodictamnus. L. Bentham.	Khatma-Robeaa	perennial grass	Apr-May	Mediterranean	Maquis on the calcareous stone
Calamintha incana. Helder.		perennial grass	May-Oct	Middle-east	Maquis on the calcareous stone

Goridothymus capitatus. L. Reichb.	Zaatar	perennial grass	May-Oct	Mediterranean	Rocky environment with hard structure soils.
Lamium maculatum. L.	Harreagh	perennial grass	Apr-May	North & East Mediterranean	
Marrubium vulgare. L	Nemela-Robeah	perennial grass	Apr-Jan	Iran & Turran	Calcareous lands & routes -- margin.
Micromeria nervosa. Desf Benthan (Satureja nervosa. Desf.)	Zatar-Elhomar	perennial grass	Feb-May	Mediterranean & Middle-east	Mediterranean steppe & rocky lands.
Nepta multibracteata. Desf.		perennial grass	May-Jul	North Africa & Portuguese	Rocks & rocky soils
Phlomis floccosa. D. Don.	Zahera- Lesless	perennial grass	Apr-May	Mediterranean	Mediterranean forests.
Prasium majus. L.	Anab-Eltheab	perennial creepy grass	Jan-Jul	Mediterranean	Maquis on the margins shade.
Rosmarinus officinalis. L.	Ackleal	perennial under scrub	Apr-May	Mediterranean	Mediterranean forests.
Rosmarinus taurnefortii. De Noe'		perennial scrub	Apr-May	Indigenous in North Africa	Rocky soil.
Salvia dominica. L. (Salvia graveoleus. Vahi.)	Tuffah-Arab Tuffah-Mezher	perennial grass	Feb-May	Middle-east	Hills side.
Salvia verbenaca. L. Brig. (ssp horminoides.)		perennial grass	Nov-Jun	Atlantic & Mediterranean	Fields & rocky environment
Satureja fontanesii. Briq		perennial grass	Mar-Apr	Middle-west	
Scutellaria peregrina. L.	Rajaah	perennial grass	Apr-Jul	Middle-east	Scrubs land.
Sideritis curvidens. Stapf		annual grass	Apr-May	Middle-east	Pine forests
Sideritis montana. L. (var. purpurea. Talbot.)	Annab-Altheeb	annual grass	Mar-Apr	Mediterranean	Rocky slopes.
Stachys tournefortii. Poiret.	Maiboos homar	perennial grass	Mar-Apr	Mediterranean	Valleys depth.
Teucricum barbeyanum. Aschors et Taub. (var. purpureum. Pamp.)	Audah	perennial grass	Mar-Apr	Indigenous	Altitude regions

Teucricum polium. L..	Audah	perennial grass	Apr-Aug	Mediterranean & Europe	Rocky steppe & arid hills.
Thymus algeriensis. Boiss et Reut.	Zatar	perennial under scrub	Jun-Jul	Indigenous in North Africa	Steppe & rocky soils.
Thymus serpyllum. L.	Zatar	perennial under scrub	Jun-Jul	Eastern Arabian Sahara	Dry sandy hills & valleys margin
(T. hovel.)					
LILIACEAE:					
Androcymbium gramineum var gramineum MC. Bride.	Balbosh hossan	perennial grass	Jan-Mar	North Africa, Palestine & Asia	
Asparagus aphyllus. L. (A. Erinaceus. Borz & Mattei.)	Jaafraz	perennial bulb scrub	Aug-Sep	Southern middle-east	Maquis.
Asparagus officinalis. L.	Aghool	perennial grass	Aug-Sep	Europe & Asia	Mediterranean maquis.
Asparagus stipularis. Forsk.	Jaafraz	perennial as a thicket	Mar-Apr-Jul-Oct	Southern middle-east	Maquis associations.
(A. Horridus. L.)					
Asphodelus micro-carpus. Salzm & Viv.	Ansoul balose	perennial tuber	Dec-Apr	Mediterranean	North of Africa.
Bellevalia cyrenaica. Maire & Weiller.		perennial bulb	Apr	Mediterranean	
Bellevalia sessiliflora. Viv & Kunth.	Balbosh	perennial bulb	Jan-Mar	Libya & Egypt	Al Kouf valley & Al Akhdar.
(Hyacinthus sessiliflorus. Viv.)					
Colchicum ritchii. R. Br. (C. Aegyptiacum. Boiss.)	Gharshood	perennial bulb grass	Oct-Dec	Middle-east	Dry & Sandy environmen
Gagea peduncularis. Pers & Pascher.		perennial bulb	Feb-May	Middle-east	Rocky soils.
Gagea trinervia. Viv & Greuter. (Anthericum trinervium.)		perennial bulb	Mar-May	Indigenous in cyrenaica	Forests & Hills slope.
Ornithogalum tenuifolium. Guss.	Harshood	perennial bulb	Jan-Mar	Mediterranean	Al Kouf valley & Al Akhdar.
Ornithogalum umbellatum. L.		perennial bulb	Mar-Apr	Mediterranean	Al Akdar & Naffusa

					mountains.
(O. Orthophyllum. Ten.)					
Scilla obtusifolia. Poiret.	Bosselah	perennial bulb	Sep-Nov	Southern Mediterranean	
Scilla peruviana. L.	Bosselah	perennial bulb	Jan-Apr	North Africa & South Europe	
(S. Hemisphaerica.					
Smilax aspera. L.	Alleag	creepy perennial grass	Nov	Mediterranean	Al Jabel Al Akhdar region
Urginea maritima. L. Baker.	Basall farown	perennial bulb	Jul-Oct	Mediterranean	Coastline sandy rocky land.
LINACEAE:					
Linum blenne. Miller.	Ghamhat jamilah	annual or biennial or perennial grass.	Mar-Jun	Mediterranean & Iran	Coastline hills.
(L. Angustifolium. Hud.)					
Linum maritimum. L.	Ragaah	perennial grass	Apr-Aug	Mediterranean	Lagoons & Swamps.
Linum nodiflorum. L.		annual grass	Mar-Jun	Mediterranean & Iran	Maquis real slopes.
(L. Luteolum. Biob.)					
Linum strictum. L.		annual grass	Mar-Jul	Mediterranean & Asia	Steppe.
Linum tenuiflora. L.		perennial grass	Mar-May	Middle - east	Meadows.
(L. Trigynum.)		annual grass		Middle - east & Iran	Maquis hills.
Linum usitatissimum. L.	Kattan	annual & biennial	Mar-Apr		
(L. Humile. Miller.)					
MALVACEAE:					
Lagunaria patersonii. G. Don.	Bethrat Afret	tree	Apr-Jun	Planted tree	Coastline.
Lavatera bryoniifolia. Miller		long-lived tree	May-Jun	Middle - east	Below the slopes.
L. tomentosa D.um					
Malva aegypyia. Linn.	Khapiza	annual grass	Mar-Apr	Mediterranean	Explored places in the forests
M. aegyptiaca J. Cullen.					

Malva nicaeensis. All.	Khapizah	annual or biennial grass	Apr-Jun	Mediterranean & Iran	
Malva sylvestris. L.	Khapazi	annual or biennial grass	Mar-May	Mediterranean	Various.
MYRTACEAE :					
Myrtus communis. L.	Merrseen	scrub	May-Aug	Mediterranean	Maquis.
OLEACEAE :					
Olea europaea. L.	Zytoon	perennial green tree	Feb-Mar-Sep-Jan	Mediterranean	Coastline.
Olea europaea. L. Var Sylvestris.	Zytoon	perennial green tree	Feb-Mar	Mediterranean	Rocky slopes.
Phillyrea angustifolia. L.	Skhaab	scrub	Mar-Jun	Mediterranean & Middle - west	Maquis.
Phillyrea latifolia. L. P. media.	Skhaab	scrub	Apr-May	Mediterranean	Maquis.
ORCHIDACEAE :					
Ophrys fusea. Link.			Feb-May	Mediterranean	
Ophrys speculum. L.			Mar-Apr	Mediterranean	
Orchis collina. Soland.		perennial bulb	Jan-Apr	Mediterranean	Dry grassland.
Orchis italica. Poir.	Syeef-ghoraab	perennial bulb grass	Mar-Apr	Europe & Asia	
OXALIDACEAE :					
Oxalis pes-caprae. Linn.	Remayh Homad	perennial bulb	Jan-Apr	Mediterranean & Iran	Moist fields.
O. cernua. Thunb.					
PAPAVERACEAE :					
Claucium flavum. Crantz.		perennial grass	Feb-Oct	Mediterranean	Coastline & sandy, rocky areas
Chelidonium glaucium. L.					
Papaver dubium. L.	Salyeatbgroon	annual grass	Feb-Mar	Mediterranean & Asia	Hard and Calcareous

					rocks.
Papaver hybridum. L.	Salyeatbgroon	annual grass	Feb-Apr	Mediterranean & Asia	Libyan coastline.
Papaver rhoeas. L. P. chaneeliae. Maire.	Salyeah	rare annual grass & biennial.	Mar-Apr	Mediterranean & Europe	
PINACEAE :					
Pinus brutea. Tenare.	Sanuber	tree	Feb-Mar	Mediterranean	Coastline and its mountains.
Pinus halepensis. Mill.	Sanuber	tree	Jul-Aug	Mediterranean	Mountains.
PLANTAGINACEAE :					
Plantago albicans. L.	Dghees	perennial grass	Feb-Jul	Mediterranean & Iran	Dry regions.
Plantago amlexicaulis. Cav.	Dghees	perennial grass	Mar-Jun	Mediterranean & Iran	
Plantago coronopus. L.		annual grass	Feb-Jun	Mediterranean & Iran	Explored spots in valleys.
Plantago cyrenaica. Durand & Barratte	Theyoelfar	annual grass	Mar-May	Libya	Eastern valleys.
Plantago lagopus. L. P. Lusitmica. L.	Wedeanah	annual grass	Feb-Jun	Mediterranean & Iran	
Plantago lanceolata. L.	Dghees	annual grass	Mar-Jul	Semi-Worldwide	
PLUMBAGINACEAE :					
Limoniastrum monopetalum. L. Boiss.	Toffah-cenje	scrub	May-Jun	Mediterranean	
Limonium pruinosum. L. Kuntze.	Rghell	perennial grass	May-Jun	Desert	Saline regions.
Limonium thouini. (viv) O. Kuntze.	Hothan	annual grass	Mar-Apr	Mediterranean & Arab desert	Dry valleys & sandy regions.
POLYCONACEAE :					
Polygonum equisetiform. Sibth et Sm.	Grthaab	perennial grass	Feb-Dec	Mediterranean	Route side & Derelict lands.
Polygonum maritimum. L.	Grthaab	perennial grass	May-Aug	Mediterranean & Europe	Sandy Calcareous soils or Shores.

Rumex crispus. L.	Hamees	perennial grass	Apr-Sep	Worldwide	Moist lands.
POLYPODIACEAE :					
Adiantum capillus veneris. L.		perennial bulb	Long-year	Semi-Worldwide	Moist regions & Caves.
Asplenium adiantum-nigrum. L.		perennial grass	Mar-Jul	Semi-Worldwide	Overshadow rocks in maquis.
Certerach officinarum. Lam et DC.		perennial grass	Mar-Apr	Semi-Worldwide	Rock cracks.
PRIMULACEAE :					
Anagallis arevensis. L. Var caerulea. A. Caerulea L. Amoen.		annual grass	Jan-Jun	Mediterranean & Europe	Middle coastline of Libya.
Cyclamen rohlfsianum. Ashers.	Arkf	perennial bulb	Oct-Dec		East North part of Libya.
RAFFLESIACEAE :					
Cytinus hypocistus. L.		parasitic perennial grass	Apr-May	South-east Mediterranean	Maquis & parasitical on scrubs.
RANUNCULACEAE :					
Adonis dentata. Del.	Aweant-Naaja	annual grass	Feb-Apr	Iran	Steppe & Desert.
Adonis micro-carpa. DC.		annual grass	Feb-Apr	Mediterranean	Fields.
Clematis cirrhosa. L.		perennial arbor	Jan-Feb	Mediterranean	Maquis.
Clematis vitalba. L.		arbor	Jan-Feb	Mediterranean & Europe	Deep valleys climbing on trees
Nigella damascena. L.		perennial grass	Mar-Apr	Mediterranean	Semi-arid regions.
Ranunculus aquatilis. L.		perennial aquatic	Feb-Mar	Tropic & moderate regions	Shallow lagoons.
Ranunculus asiaticus. L.		perennial bulb	Feb-May	West-Mediterranean	Maquis on the rocky hills.
Ranunculus millefolius. Banks et sol.		perennial grass	Feb-Apr	Middle-east & Iran	Maquis & steppes.
Ranunculus muricatus. L.	Aweant-Naaja	annual grass	Mar-Apr	Mediterranean	Moist lands with heavy soils.
Ranunculus rectirostris. Coss et Dur.		perennial grass	Mar-May	North Africa	

RESEDACEAE :					
Reseda alba. L. ssp. Alba.	Eshbat-ghola	annual & biennial grass	Feb-Apr	Europe & North Africa	Various.
Reseda lutea. L.		annual & biennial grass	Mar-Apr	Europe & North Africa	Worldwide.
R. Truncota. Fish & Mey. SSD. Lutea.					
Reseda luteola. L.		annual & biennial grass	Mar-Jun	Europe, North Africa & Asia	
RHAMNACEAE :					
Rhamnus alaternus. L.	Sllof.Cettar.Gbar	perennial scrub	Jun-Sep	East-part of Libya	Ceriene & Al Jabal Al Akhdar.
Rhamnus lycieides. L. ssp aleoides. (L.) Jah. et Maire.	Sllof.	perennial scrub	Jun-Sep		
Rhamnus oleoides. L.	Sllof	scrub	Mar-Jun		Widespread on hills top.
Ziziphus lotus. L.	Cdeer	thorny scrub	Mar-Apr	Mediterranean & Sudan	Valleys side.
ROSACEAE :					
Eriobotrya japonica. Lind.	Naspoli	scrub	Oct-Jan	China	Fields.
Sanguisorba minor. Scon.	Sheprig-Shronia	perennial grass	May-Jun	Mediterranean & Iran	Maquis.
Poterium sanguisorba. L.					
Sarcopoterium spinosum. L. Spach.	Sheprig	perennial sub-scrub	May-Jul	Middle-east	Common in the east of Libya.
Poterium spinosum. L.					
RUBIACEAE :					
Crucianella maritima. L.	Belbalasreef	perennial sub-scrub or grass.	Jan-Apr	Mediterranean	Close to the coastline.
C. rupestris. Guss.					
Galium tricornutum. Dandy.	Dbegah	annual grass	Feb-Apr	Europe, Mediterranean, Iran	Field & Derelict lands.

				& Pakistan.	
G. tricorne. Stokes.					
Galium verrucosum. Huds.		annual grass	Feb-Apr	South Europe & Mediterranean	Coastline.
Putoria calabrica. Pers.	Zregah	scrub	Jun-Oct	Mediterranean	Libyan eastern coastline.
Asperula calabrica.					
Rubia peregrina. L.		perennial grass	May-Jun	Mediterranean	Height maquis.
Sherardia arvensis. L.	Rajah-Madidah	annual grass	Mar-Jun	Mediterranean	Common in the height regions in the eastern part of Libya.
Valantia lanata. Delile & Coss		annual grass	Mar-May	Egypt & Libya	Al Jabal Al Akhdar.
V. Hispida. Auet.					
SANTALACEAE :					
Osyris alba. L.		short scrub	Mar-Apr	Mediterranean	
Thesium humile. Vahl.	Habb-Greash	annual & biennial grass	Feb-Apr	Mediterranean	Semi-parasite on coastline
SCROPHULARIACEAE :					
Linaria micrantha. (cav) Hoffsg.		annual grass	Feb-Apr	Mediterranean & Iran	Derelict fields.
Antirrhinum micranthum. (cav).					
Linaria scariosa. Desf.		annual grass	Mar-Apr	Algeria, Tunisia & Libya	
Linaria triphylla. L. Miller.		annual grass	Mar-May	Mediterranean	Derelict land.
Parentucellia latifolia. L. Garuel.		annual grass	Mar-Apr	Mediterranean & Europe	Steppe.
Scrophularia arguta. Solander.		annual grass	Mar-Apr	Mediterranean & Desert	Moist & shadowed places
Scrophularia canina. L.	Eship-Alghola	perennial grass	Mar-Apr	Mediterranean	Valleys side.
Scrophularia peregrina. L.		biennial grass	Mar-Apr		Routes side.
Verbascum sinuatum. L.	Raghmah	biennial grass	Apr-Oct	Mediterranean & Iran	Fields & Derelict land.

SOLANACEAE :

Datura metel. L.		annual grass	Jan-Nov	South America	Derelict land.
Lycium europaeum. L.	Aosage	perennial scrub	Long-year	Mediterranean	Saline regions.
L. Mediterraneum. Dunal.					
Var. Ramulosum. Dunal. Fiori.					
Solanum nigrum. L. Var villosum. L.	Anab-Altheeb	annual grass	Long-year	Mediterranean & Iran	
TAMARICACEAE :					
Reaumuria vermiculata. L.		scrub	Jun-Nov	North Africa & South Europe	Coastal Gypsum Sands.
Tamarix africana. Poir.	Athl	scrub	Mar-Jun	North Africa & South Europe	Coastal Sands.
THYMELAEACEAE :					
Daphne jasminea. Sibth et Sm.		perennial sub-scrub	Apr-May	North Africa	Rocky regions.
Thymelaea hirsuta. L. Endi.	Metnan	short scrub	Sep-Oct	Mediterranean	Dry regions (arid).
Passerina hirsuta. L.					
UMBELLIFERAE :					
Ammi majus. L.		annual grass	Jun-Aug	Mediterranean	Fields & routes side.
Ammoides verticillata. (Desf) Briq.		annual grass	Mar-Apr	Mediterranean	
Bifora testiculata. L. Roth.	Gengin	annual grass	Mar-Apr	Mediterranean	Fields (harmful grass).
Bupleurum lancifolium. Hornem.		annual grass	Mar-Jun	Mediterranean	Fields (harmful grass).
Bupleurum lancifolium var lancifolium. Hor.		annual grass	Mar-Jun	Mediterranean & Iran	Fields among the winter crops.
B. Protractum. Hoffmanns. et Link.					
Bupleurrum semicompositum. L.	Wageh-Nasseba	annual grass	Feb-Apr	Mediterranean & Iran	Arid steppes.
Conium maculatum. L.		biennial & perennial grass	Apr-Jun	Mediterranean & Europe	Derelict lands & routes side.
Daucus gingidium. L.		annual grass	Mar-Apr	Mediterranean	
Eryngium campestre. L.	Foggah	perennial grass	Mar-Apr	Mediterranean & Europe	Accompanying local scrubs.

Lagoecia cuminoides. L.		annual grass	Mar-Apr	Middle-east & Iran	Fields.
Malabaila suaveolens. (Del) Coss.	Talghodi	biennial grass	Mar-Apr	Middle-east	
Pseudorlaya pumila. L. Grande.		annual grass	Mar-May	Mediterranean	Coastal sands & Valleys side.
Orlaya maritima. Koch.					
Scandix australis. L.		annual grass	Mar-Apr	Mediterranean	
Scandix pecten-veneris. L.		annual grass	Mar-Apr	Mediterranean & Iran	Fields.
Sison amomum. L.	Zetah	perennial grass	Mar-Apr	North Africa	
Smyrnium olusatrum. L.		perennial grass	Mar-Apr	Mediterranean	Valleys floor.
Thapsia garganica. L.	Deryas	perennial grass	Mar-Apr	Mediterranean	Common on the hills.
Tordylium apulum. L.		annual grass	Mar-Apr	Mediterranean	Accompanying local scrubs in a shadowed areas.
Torilis nodosa. L. Gaertn.		annual grass	Mar-May	Mediterranean & Iran	Routes side & Derelict lands.
URTICACEAE :					
Urtica pilulifera. L.	Harreag	annual grass	Feb-Apr	Mediterranean & Iran	Field & Derelict lands.
U. Balearica. L.					
VALERIANACEAE :					
Centranthus calcitrapae. L. Dufresne.		annual grass	Mar-May	Mediterranean	
Valeriana calcitrapae. L.					
Fedia cornucopiae. L. Gaertner.	Zarah-Alfakrona	annual grass	Feb-Apr	South Mediterranean	Al Jabal Al Akhdar & Al Koff.
Valerianella petrovichii. Asherson.	Loktah	annual grass	Mar-Apr	North of Libya	
Valerianella truncata. (Reuchli) Betcke…	Toamat-Arnab	annual grass	Mar-Apr	Mediterranean & Iran	Fields.
Valerianella vesicaria. L. Moench.	Toamat-Arnab	annual grass	Mar-Apr	Mediterranean & Iran	Al Jabal Al Akhdar & Al Koff.
V. Locusta. L. var. vesicaria. L.					

VIOLACEAE :					
Viola scorpiuroides. Coss.	Katifa Syedah	perennial grass	Jan-Mar	Middle-east	Calcareous rocks in Al Akhdar.
ZANNICHLLIACEAE :					
Zannichellia palustris. L.		grass	Apr-Jun	Worldwide	Lagoons.
ZYGOPHYLLACEAE :					
Nitraria retusa. (Forsk) Aschers.	Ghardk	scrub	Mar-Jun	Mediterranean & Iran	
Zygophyllum album. L.	Trtear	perennial sub-scrub	Oct-Apr	Mediterranean	

Appendix No. 3

Quarry Restoration and After-use in the UK

Site Name	Location	Grid Ref.	Ownership	Product	Dates worked	Planning Permiss-ion ends	How restored and/or proposed after-use	Other Comments
1- Glen Quarry	Stainton, Maltby	SK 548947	Marshlls Mono Ltd.	Limestone for Aggregate	1945 20 ha's	2018	Low level restoration.	There are more restoratic plans for the future.
2- Spaunton Quarry	Pickering	SE 722866	RMC Aggregate (Northern) Ltd.	Limestone	1900 120 ha's	2007	Landscape, tree planting	The site's status is curren active.
3- Whitehill	Burford	2610 SP 277095	Burford Quarry Ltd	Jurssic, White Limestone			May be re-opened	The site's status is curren dormant.

4- Woodeaton	Oxford	5312 SP 533123	J Barney	Jurassic, White Limestone			May be re-opened	The site's status is curren dormant.
5- Coldstones Quarry	Pateley Bridge Harrogate	SE 123640	Pioneer Aggregates	Roadstone	1820 & 1992 0.5 ha	2045	Back-filling & nature conservation.	The second date is belon Pioneer Aggregates Company permission.
6- Holton Quarry	Holton Oxfordshire	5906	Local Authority	Limestone	No Informat-ion	No Informat-ion	New Car Storage. No restoration.	
7- Church Farm	Shellingford Oxfordshire	6025 SU 327937	Multi-Agg Ltd.	Jurassic Limestone				
8- Town Quarry	Charlbury	3619 SP 368198	S & J Quarries Ltd	Jurassic, White Limestone			Being restored for nature conservation/amenity.	

9- Ardley Wood	Bicester Oxfordshire	5327 SP 532271	Smith & Sons (Bletchingt-on) Ltd.	Jurassic, Great Oolite			Nature Conservation.	
10- Horsebottom Quarry	Filkins	2306	Local Authority	Limestone	No Informat-ion	No Informat-ion	Restored to agriculture.	No blasting restoration.
11- Fairgreen Farm Quarry	Sarsden Oxfordshire	SP 301227	Downs Stone Co	Jurassic Limestone				
12- Slape Hill Quarry	Glympton Oxfordshire	SP 424197	Smith & Sons (Beltchingt-on) Ltd.	Jurassic Limestone				

13- Stoke Hill (Hays Wood) Mine	Bath	ST 778608	Bath Stone Group	Jurassic, Great Oolite Limestone	1600 1937 1981	2099	Back-fill, no any specific restoration plans.	
14- Stowey Quarry	Bishop Sutton	ST 598587	Stowey Quarr & Lime Co Ltd.	Jurassic, Building Limestone	1907 20 ha's	No Informat-ion	Nature conservation, back-fill.	
15- Upper Lawn Quarry	Bath	ST 766624	J Hancock & Sons (Bath) Ltd.	Jurassic, Great Oolite Limestone				
16- Barton Quarry	Darlington	NZ 218078	Sherburn Stone Ltd.	Limestone	1945 70 ha's	2043	Low level restoration, and high level restoration with tree planting.	

17- Greenfield Wood	Waltington	7190						
18- Shellingford Quarry	Shellingford Stanford	SU 324937	Multi-Agg-Ltd	Jurassic Gravel				
19- Church Farm Quarry	Shellingford	SU 327227	Multi-Agg-Ltd	Limestone				
20- Broadway (Fishill) Quarry	South Leigh Broadway.	SP 116368	Smith & Sons (Bletchingt-on)Ltd	Jurassic Limestone	1940's 9 ha's	2015	No restoration.	
21- Coombefield Quarry	Isle of Portland	SY 690705	ARC-Bath & Portland Natural Stone.	Jurassic & Portland Limestone				

22- California Farm Quarry	Swanage Dorset	SZ 022776	J Suttle Swanage Quarries.	Building Stone Limestone				
23- Swanage Quarry	Swanage Dorset	SZ 015785	J Suttle Swanage Quarries.	Building Stone Limestone				
24- Doulting Stone	East of Doulting	6443	Doulting Stone Co Ltd	Building Stone	1960 1.2 ha's	2042	To a woodland conservation after-use.	No excavation below 20[illegible] 2500 tonnes per annum.
25- Appledore Field Quarry	South west of Somerset	4630		Blue Lais Limestone	1949 3.78 ha's	2042		The status is Dormant. Shallow quarry.
26- Ashen Cross	South east of Somerset	7442		Blue Lais Limestone	1951 8.9 ha's	2042	Restoration to agriculture	Active with output limit[illegible] 6000 tonnes over consecutive three years period.

27- Badger's Cross	South of Somerset	4961		Blue Lais Limestone	1954 2.18 ha's	2042	No restoration.	Dormant, original permis was 1949.
28- Barnclose	North of Leigh upon Mendip	5054 5255		Various Limestone Aggregate	1970 13.73 ha's	2042	No restoration.	Dormant.
29- Battscombe	North of Cheddar	4553 ST 460550	ARC Southern	Various Limestone	1948 60 ha's	2042	Quarry faces and benches shall be progressively restored, reclaimed to a state suitable for amenity, agriculture, foresty or other use.	The site is still active, producing kiln for use in steel and chemical indus The remainder is used to produce aggregate, used as roadstone and as a concrete aggregate.
30- Bullan's Close	Northern edge of Charlton Mackrell.	5228		Jurassic Limestone -BlueLais	1951 3.2 ha's	2002	No restoration.	The site is still active, th uses of the output are, building, walling, roofin and paving stone.

31- Callow Rock	North west of Cheddar	4553 ST 446558	Bardon Aggregates Southern Ltd	Carbonifer -ous Limestone	1948 43.3 ha's	2042	No restoration.	The site is still active, mu of the output leaves the s as concrete products at th on-site works.
32- Capton Quarry	Williton	0840 ST 079393	Capstone Sandstone Quarry	Triassic Sandstone Marl	1992 0.32 ha's	2007	Restoration to nature conservation, with tree planting and a lake.	The site is still active, ou not to exceed 1000 tonne per annum.
33- Castle Cary	South east of Castle Cary	6332		Oolithic Limestone	1986 0.38 ha's	2006	No restoration.	The site is still active, ou is limited to 2500 tonnes annum.
34- Castle Hill	North west of Bridgewater	2839 ST 252405	Castle Hill Quarry Ltd	Carbonifer -ous Limestone	1947 10.7 ha's	2042	No restoration.	The site is still active, ou is limited to 190.000 ton per annum averaged thre years.

35- Cannington Park	NW of Bridgwater	2539 ST 252405	Castle Hill Quarry Co Ltd	Carbonifer-ous Limestone	1947 4.8 ha's	2000 is due for review	No restoration.	Dormant.
36- Chard Junction	Thormcombe South east of Chard	3208 ST 345045	Bardon Aggregate Southern, Southwest Region.	Sand and Gravel	1965 0.6 ha's	2001	To a water area for wildlife.	The site is still active, out is limited to 190.000 per three years.
37- Cloford	South west of Frome	7747		Carbonifer-ous Limestone	1948 40.6 ha's	2042	No restoration.	Dormant, the product use Aggregate.

38- Cookswood / Holcombe	North east of Shepton Mallet	6143	Tarmac Quarry Products Southern.	Carbonifer -ous Limestone Aggregate	1947 57.1 ha's	2042	No restoration, but there are some concerns about the impact of traffic, the effects on the groundwater, the implications for nature conservation and landscape visual impacts.	Dormant.
39- Copse	South west of Henstridge	7219		Jurassic Limestone -Forest Marble	1949 0.24 ha's	2002	To nature conservation after-use. The retention of faces representing the geological succession has been requested.	The site status is active-intermittent. No excavati below 41.25m. Output should not exceed 500 to per annum.

40- Doulting	North east of Doulting	6443 ST 649433	Doulting Stone Co Ltd	Jurassic Limestone - inferior ooolite	1951 10.5 ha's	2042	No restoration.	The site status is active, output should not exceed 6000, no worhing below 210m.
41- Downslade	South west of Somerton	4828 ST 455269	Downslade Quarry Ltd	Jurassic Limestone -Blue Lias and White Lias	1992 2.16 ha's	2006	A requirement for progressive restoration.	The site status is active, output should not exceed 2500 tonnes per annum, r excavation below 43m.
42- Dulcote	South east of Wells	5445 ST 567444	Foster & Yeoman Ltd	Carbonifer -ous Limestone	1998 22.9 ha's	2013	No restoration.	The site status is active, output should not exceed 240,000 tonnes per annur

43- Emborough	North of Shepton Mallet	6143		Carbonifer-ous Limestone	1948 41 ha's	2042	No restoration, the site is currently used for the manufacture of concrete products. A small area in the North is used for recycling. The site is used for military training.	The site status is dormant
44- Gurney Slade	North of Shepton Mallet	6143 ST 626497	Morris & Perry Ltd	Carbonifer-ous Limestone -Hotwells Limestone	1947 73.9 ha's	2042	No restoration.	The site status is active, annual output is limited t million tonnes.

45- Halecombe	West of Frome	7747 ST 702475	Tarmac Quarry Products Southern	Carbonifer -ous Limestone	1992 60 ha's	2016	No restoration, but requirement was approved in 1997, subject to a legal agreement to provide for continued surface and groundwater monitoring.	The site status is active.
46- Ham Hill North	West of Yeovil	5515 ST 477173	Ham & Doulting Stone Co Ltd	Building Stone	1950 1.0 ha's	2009	Restoration to a nature conservation afteruse.	The site status is active, w possibility of extention granted.
47- Hamdon Hill South	West of Yeovil	5515 ST 482162	Ham Hill Stone Co Ltd	Building and walling stone	1951 4 ha's	2017	No restoration.	The site status is active, output not to exceed 600 tonnes per annum, no excavation below 96 m.

48- Highcroft	North of Shepton Mallet	6143		Carbonifer -ous Limestone -Clifton down Limestone	1948 7.1 ha's	2042	No restoration.	The site status is dormant
49- Holwell (Colemans)	South west of Frome	7747 ST 726453	Bardon Aggregate Southern	Various kinds of Limestone	1942 61.9 ha's	2015	No restoration.	The site status is active, r working below 120 m.
50- Lake View	SW of Keinton Mandeville	5430 ST 548304	C M Pearce	Jurassic Limestone Building Stone	1951 9.2 ha's	2042	Restoration to nature conservation, with a lake and area for agriculture.	The site status is active, output shall not exceed 1 tonnes over 36 months.

51- Landshire Lane (Henstridge)	SW of Henstridge	7219		Jurassic Limestone -Forest Marble	1997 1.7 ha's	2008	Restoration to agriculture	The site status is active, output not to exceed 500 tonnes per quarter, no excevation below 45 m.
52- Lime Kiln Hill	West of Frome	7747 ST 732488	Lime Klin Hill Quarry Co.	Limestone	1950 8.1 ha's	2042	TheEastern side shall be restored to a forestry use of broad leaved native trees. Part of the Quarry is used as a waste recycling centre and for wood chipping composting.	The site status is dormant working below 95 m.

53- Moons Hill	NE of Shepton Mallet	6143		Silurian andesite-Basalt Trade Group. Roadstone	1995 95.1 ha's	2042	No restoration.	The site status is active, th site has significant depth o overburden to be removed and disposed of.
54- Old Station Yard	Eastern edge of Charlton	5228	Barham Bros Ltd	Jurassic Limestone -Blue Lias	1990 0.83 ha's	No agreeme-nt	No restoration.	The site status is dormant application for an extentio of time has been submitte
55- Shipham Hill	South of Shipham	4457		Carbonifer-ous Limestone	1948 20.8 ha's	2042	A vegetated south facing slope will be reinstated.	The site status is dormant is unlikely that this quarry will re-open whilst Callo Rock retains reserves.

56- Station Quarry	Eastern edge of Charlton Mackrell	5228 ST 532290	Barham Bros Ltd	Jurassic Limestone -Blue Lias	1948 11.86 ha's	No Informati on.	Progressive restoration to agriculture.	The site status is active, maximum output 4000 tonnes per annum, no excavation below 4 m dep
57- Stoke Lane	NE of Shepton Mallet	6143		Carbonifer -ous Limestone	1976 2.85 ha's	2042	No restoration.	The site status is dormant output not to exceed 35,0 tonnes per annum.
58- Tadhill	NE of Shepton Mallet	6143		Silurian Andesite	1947 16 ha's	2042	No restoration.	The site status is dormant and unlikely that the site re-open.
59- Tor Hill	SE outskirts of Wells	5445		Carbonifer -ous Limestone	1947 6.4 ha's	2042	No restoration, industrial units have been developed within the quarry complex.	The site status is dormant there is the possibility of small scale quarrying to f the concrete works.

60- Torr Works	East of Shepton Mallet	6143 ST 695439	Foster, Yeoman Ltd	Carbonifer -ous Limestone	1999 is the new condition -al permiss- on. 313 ha's	2030	The shallow outer faces of the banks will be returned to agriculture use with hedges, hedgerow trees and small blocks of woodland. Proposed scree placement with planting on benches.	The site status is active, output shall not exceed 6 million tonnes per annum excavation below 115 m.
61- Tout	Southern boundary of Charlton Adam	5328 ST 5372830	Morris & Perry Ltd/Ham & Doulting Stone Co Ltd	Jurassic Limestone -Blue Lias	1993 2.24 ha's	2018	No restoration.	The site status is active, output not to exceed 240[illegible] tonnes perannum, no mi[illegible] extraction below 44 m.

62- Vinnicombe	East of West Quantoxhead	1543		Devonian Sandstone	9.4 ha's	2042	No restoration.	The site status is dormant. The site is unlikely to resu working.
63- Westbury	NW of Wells	5445		Aggregate Limestone	1986 8 ha's	2015	No restoration.	The site status is active, output not to exceed 300,0 tonnes over 60 calendar months.
64- West Cranmore	East of Shepton Mallet	6143 ST 661431	R J Dennett	Jurassic Limestone - Oolothic Limestone	1957 1.53 ha's	No Informati on.	Woodland / nature conservation with two accessible reck faces in the Doulting Stone.	The site status is active, output not to exceed 12,0 tonnes per annum, works below 192 m.

65- Westdown	South west of Frome	7747		Aggregate Limestone	No working will recmmen -ce before 2015 67.4 ha's	2042	The reclamation scheme has not been submitted and agreed by MPA.	The site status is dormant.

66- Whatley	West of Frome	7747 ST 727481	ARC Southern	Limestone for aggregate	1948 180 ha's	2030	The quarry faces and benchesshall be restored progressively and managed for nature conservation purpose. The worked out quarry (which will be a water filled area) shall be used for water resources purpose only. The margins of the lake shall be designed to afford scope for nature conservation after use.	The site status is active, output of the site shall not exceed 20 million tonnes over the period 1. 1. 98-31. 12. 2000, or 24 millio tonnes over any successiv calendar years.

67- Forcett	Richmond North Yorkshire	415400 E 511000 N	Tilcon (North)	Hard Rock limestone	1993	2012	To agriculture, and lake for recreation.	Output 250,000 tonne per annum.
68- Croft	Croft Leicestershire	451200 E 296300 N	Aggregate Industries (Bardon)	Hard Rock Limestone	1940's 200 ha's	2029	No restoration.	Output 200,000 tonne per annum.
69- Swinden	Skipton Yorkshire Dales	398100 E 461500 N	Tilcon	Hard Rock	1996 68.9 ha's	2020	Restoration to nature and lake by 2020.	Lime is no longer produce
70- Bayston Hill	Baston Hill (Shrewsbury)	309100 N 349300 E	Tarmac	Gritstone			No restoration.	Output 750,000 tonne per annum.
71- Chipping Sodbury	Chipping Sodbury	372400 E 183300 N	ARC	Limestone	1974 120 ha's	2042	To water storage and recreational area.	Output 1million tonne pe annum.

72-* Cadeby Quarry	5 km South West of Doncaster	522007	Redland Aggregates Company	Limestone	1948 97 ha's	2060	Resotred to agricultural standard land and is classified as rough pasture area due to the slope gradient.	The planning permission f the site is directly related t the restoration process.
73-* Levitt Hagg Quarry	West of Doncaster	537004	Doncaster Local Authority	Limestone	1629	1950	Restored to it's original landform by means of bakfilling with domestic waste.	The site's area was worke for a short while after wor war two, but by the 1950's Levitt Hagg was left dese and derelict.

74-*Nursery Lane Quarry	Between the villages of Sprothrough and Cadeby	534015	Sharing between the Redland Company 2.12 ha & Local authority 7.08 ha.	Limestone Building stone & facing stone.	1951 9.2 ha's	1976	The quarry re-graded and reclaimed during the summer of 1990. The site was restored to nature conservation and public amenity.	The quarry has been stood idle for approximately twenty years, and in this ti a diverse magnesian limestone grassland flora l developed.
75-*Nearcliff Quarry	On the southern bank of the river Don.	527994	Local authority	Limestone	1834 1.5 ha's	1931	Left to re-colonise naturally. In 1986 The English Nature added Nearcliff woodland and it's quarries to the South Yorkshire Inventory of Ancient Woodlands.	

76-*Farcliff Quarry	0.5 km West of the village of Warmsworth	533003	Local authority	Limestone	1841 4 ha's	1951	Left to re-colonise naturally.	The ecology of the site's regeneration has taken approximately 50 years or more of development.
77- Holme Hall Quarry	Rotherham	SK 545940	Tarmac Quarry Product	Limestone for aggregate	1928 143 ha's	2025	Soil replacement for agriculture restoration.	Coal waste has been repla for land-fill the finished si
78- Hope Quarry	Castleton	SK 159815	Blue Circle Industries PLC	Carrbonife rous Limestone for Cement	1929			

Quarry Restoration and After-use in Libya

Site Name	Location	Grid Ref	Ownership	Product	Dates Worked	Date of Closure	How restored and to what use	Other Comments
1- Al - Gughbub Quarry No.1	South of the Village	2429 EN	Tobruk Municipal-ity	Gypsum Chalk belonging to Jaghbub formation	1896 3.8 ha's	1969	Restored to Agriculture purposes (Dates, Olive, and citrus farm).	The Quarry opened by the newly arrived tribes from Algeria, Chad, and West c Libya during the Colonizations Era.

2- Al - Gughbub Quarry No.2	West of the Village	2429 EN	Private Property	Gypsum Chalk belonging to Jaghbub formation	1970 15 ha's	2025	The finished side restored to agricultural purposes (Dates, Olive, and citrus farm, with some production of vegetables.	The output of the Quarry i locally used by the residen of the village.
3- Al-Bardia (Zahr Taieb el Esm site)	West of Al-Bardia	2431 N	Developing Companies	Limestone	1970's	Un-Known time	No restoration may re-open	The site status is dormant.
4- Tammemi Limestone Quarry	South of the Village	2332 NE	Private Company	Limestone Building stone	1966 2 ha's	Un-limited date	Finished side converted to an animal yard (Cattle)	The site status is active.
5- Al - Bombah Building Stone Quarry	South of the Village	2332 NE	Libyan Army	Limestone Building stone	1973 1.5 ha's	1985	No restoration. May be re-opened soon.	The site is in forebidden area at the nowdays.

6- Oummarzam Quarry	West of the Village	2332 NE	The Developme-nt Sector	Limestone Building stone	1970 2 ha's	1998	No restoration, the site has become used for casual waste dumping.	
7- Martobah Limestone quarry	2 km South of the Cement plant	2232 N	The Libyan Cement Company	Limestone	1984 140 ha's	2067	No restoration.	Output 1 116 000 tonnes p year.
8- Martobah Clay Quarry	2 km South East of the Cement Plant	2232 N	The Libyan Cement Company	Clay	1984 18 km to S, 8 km to E	2030	The East slopes of the quarry have been restored to agriculture use.	Output 528 000 tonnes pe year.
9- Wadi Al-Naghah Quarry	8 km West of Derna	2232 N	Private Company	Limestone Building stone	1970 0.5 ha	2005	Finished side left to recolonise naturally.	The site is located on the Motorway side.

10- Sidi Khlid Building stone Quarry	15 km West of Derna	2232 N	Tribe Property	Limestone Building stone	1960's 1.5 ha's	1994	Restored to be a private farm, with Cattle yard.	The site is located on the Motorway side.
11- Al-Gubbah Building stone Quarry	40 km West of Derna	2232 N	Tribe Property	Limestone Building stone	1960's 7.5 ha's	Un-Limited date	The western side of the Quarry restored to residential row.	The site is surrounded by green area.
12- Lamlodah Limestone Quarry	10 km West of Gubbah	2232 N	Libyan Army Company	Limestone	1977 1 ha	1990	Left to recolonise naturally.	
13- Al-Faidiyah Quarry	South of Al-Bida	2132 N	Libyan Transportat-ion Body	Limestone	1977 3 ha's	1994	Restored to football ground.	The site is based on Al Faidiyah Formation Limestone.
14- Al-Abraq Dolomitic Limestone Quarry	East of Al-Bida	2132 N	Private Investment	Limestone	1970 10 ha's	Un-limited Date	Some parts restored to Agriculture.	The site is based on Al-Abraq Formation.

15- Al Ghariga Quarry	South of Al-Bida	2132	Al-Bida Municiba-ity	Limestone	1960's 4 ha's	1980's	Part of the Quarry left to recolonise naturally, on the other part sewage refinery being established	
16- North of Al-Bida Quarry	North of the City	2132	Libyan Transportat-ion Body	Limestone for Aggregate	1970's 2 ha's	Un-Limited Date	No restoration.	The site's status is now as dormant, and located clos new motorway project.
17- Ghernada (North) Building stone Quarry	North of the Village	2132	Private Investment Sector	Limestone Building stone	1960's 2-3 ha's	1980	Restored to commercial use.	The excavation operation being moved to the south the Village.
18- Ghernada (South) Quarry	South of the Village	2132	Private Investment Sector	Limestone Building stone	1980 10 ha's	2015	No restoration.	The site status is active.

19- Susah Aggregate Quarry	West of City of Susah	2132	Libyan Transportat-ion Body	Limestone	1977 3.5 ha's	Un-limited Date	No restoration.	There is a dispute betwee the local people and the investor about the emissic released from the quarry operations.
20- Susah Ancient Limestone Quarry	South of the Ancient City	2132	Libyan Heritage Organisat-ion	Limestone Building stone	Un-known 2 ha's	Long time ago	Recolonise naturally.	The local people plan is t re-open the quarry for lei purposes.
21- The Mountain Quarry	South West of the city of Susah	2132	Private Company	Limestone , Marble	1980 1.8 ha's	Un-Known	No restoration.	The quarry product is for building uses.
22- Shahat Ancient Quarry	South of the Ancient City	2132	Libyan Heritage Organisat-ion	Limestone Marble	Un-Known 4 ha's	Un-Known	The Southern part left to re-colonise naturally, the Northern part converted to Football ground.	The Libyan Heritage Organisation future plan re-excavate the quarry fo scientific purposes.

23- Al-Kufe Quarry	West of the City of Al-Bida	2132	Libyan Transport-ion Body	Limestone	1965	1990	Restored within the Al-Kofe National Park project preperation.	The Quarry become a hou of animals.
24- Al-Shaluni Limestone Quarry	East of the City of Al-Marij	2032	The Enterprises of the city Company	Limestone	1963 11 ha's	2010	The south part of the quarry become waste dumping site, the north part is still active.	The Quarry opened after 1962 Earthquake in order re-build the city.
25- Al-Kharroba Aggregate Quarry	50 km south of Al-Marij	2131	Al-Fadil Militry Company	Limestone	1980 4 ha's	2005	No restoration.	The Quarry product is fo roadstone.
26- Hawsh Al-Hawwari Limestone Quarry	8.5 km south of Benghazi	2032	Libyan Cement Company	Limestone for Cement	1972	2025	No restoration.	The Environmental Grou have complaining severa times adainst the quarry operation emissions.

27- Benghazi Al-Hawwari Clay Quarry	South of Al-Hawwari Cement plant	2032	Libyan Cement Company	Red Clay for Cement	1972 120 ha's	2025	Agriculture restoration.	The thick of layer reach si metre underlaied by a thic limestone layer.
28- Tolmeta Ancient Quarry	On the edge of the old city	2032	Libyan Heritage Organisat-ion	Limestone , Marble	Un-Known 4 ha's	Un-Known	Left to recolonise naturally.	The Libyan Heritage Org plan is to re-open the quar for scientific excavations.
29- Tuckra Aggregate Quarry	South of City of Tocra	2032	Tocra Municipal-ity	Limestone	1972 3.9 ha's	2000	No restoration.	The quarry is based on an Ancient Quarry by ignora
30- El-Abiar Aggregate Limestone Quarry	1 km of the City of Al-Abiar	2032	Benghazi Civil Enterprises	Limestone	1972 6 ha's	2010	The finished sides vegetated by foresty trees.	The lower layer contain p marble.
31- El-Abiar Gypsum Quarry	East of the City	2032	Libyan Cement Company	Gypsum	1976 7.6 ha's	2015	The finished side isolated for commercial use.	The quarry's production i for Al-Hawwari Cement Factory.

32- El-Abiar Chalk Quarry	South West of the City	2032	Benghazi Chemical Company	Chalk	1975 5.3 ha's	Un-Known	No restoration.	The site operations are no static.
33- Al-Rajmah Limestone Quarry	South of Benghazi	2032	Libyan Cement Company & Benghazi Enterprises	Limestone	1966 20 ha's	Un-Known	No restoration.	The site's status is current active.
34- Benina Building stone Quarry	South of Benghazi	2032	Private Investment	Limestone Building stone	1970's 3 ha's	Un-Known	No restoration.	The site's status is curren active.
35- Solluk Aggregate Limestone Quarry	West of Benghazi	2031	Benghazi Civil Enterprises	Limestone Aggregate	1970's 30 ha's	2010	Restored for Agriculture use.	The site level not to exce 6m high

36- Zawiyat Masus Gypsum Quarry	South East of Benghazi	2131	Libyan Cement Company	Gypsum	1970's 5.2 ha's	2015	The finished site is isolated to be a Cattle Yard.	The site's status is current active.
38- Zawiyat Masus Limestone Building stone Quarry	South East of Benghazi	2131	Private Investment	Limestone Building stone	1970's	Un-Known	No restoration.	The site's status is current active.
39- Ajdabiya (A) Building stone Quarry	North of the City	2030	Private Investment	Limestone Building stone	1960's	Un-Known	Finished site restored to be hay storage, and Cattle market.	The site's status is current active.
40- Ajdabiya (B1)	North of the City	2030	Private Investment	Limestone Building stone	1960's	Un-Known	No retsoration.	The site's status is current active.

41-Ajdabiya (B2)	North of the City	2030	Private Investment	Limestone Building stone	1970's	Un-Known	No restoration.	The site's status is current active.
42- Ajdabiya Al-Sahil	North of the City	2030	Libyan Transport-ion Body	Chalk	1979	Un-Known	Finished site become a winter water reservoir for Cattle drinking.	The site's status is current active.
43- Al-Washkah Aggregate Quarry	West of Ajdabiya	1930	Ajdabiya Civil Enterprises	Limestone	1970's	Un-Known	No restoration.	The site's status is current dormant.
44- Al-Aqaylah Aggregate Quarry	West of Ajdabiya	1930	Libyan Artificial River Company	Limestone	1980's	2010	No restoration.	The site's status is current active.

45- Qasr Sirt Quarry	South East of the City of Sirt	1631	City of Sirt Municipal-ity	Limestone Building stone & Aggregate	1970's	Un-Known	Finished site restored to commercial use, and establishing new stadium , the southern part of the quarry planted by Fruit Trees.	The City of Sirt has extend tenth times than before 20 years, so the quarry operations are threaten by new projects in the city
46- Abu-Hadi Aggregate Quarry	South west of the City of Sirt	1530	Sirt Civil Enterprises	Limestone Aggregate & Gypsum	1980's	Un-Known	No restoration.	The site is in arid area, an still active.
47- Bu-Njim Building stone Quarry	South west of Sirt	1530	Private Investment	Limestone Building stone	1980's 15 ha.s	Un-Known	Agriculture restoration, Dates and Olive trees.	The site's status is current active.
48- An-Nufaliyah Building stone Quarry	Sout East of Sirt	1730	Private Investment	Limestone Building stone	1970's 10 ha's	Un-Known	Agriculture restoration, Dates and Olive trees.	The site located on the Motorway side, and still active.

49- Misratah Chalk Quarry	South of the City of Misratah	1532	Libyan Steel Company	Chalk	1980	2050	Steel production storage.	The site was opened by th new Libyan Steel Compa of Steel production uses.
50- Misratah Building stone Quarry	South West of Misratah	1532	Private Investment	Limestone Building stone & Chalk	1960's 1.2 ha's & 1.5 ha's& 3.2 ha's	Un-Known	Finished sites restored to residential area, and vegetable and food markets.	The currently active sites close to the completed sit and the City Centre.
51- Tawerghah Chalk Limestone Quarry	East of Misratah	1532	Libyan Steel Company & Railway Company	Chalk	1980	2050	No restoration.	The site's status is current active, sharing between th two companies.
52- Hun Gypsum & Chalk Limestone Quarry	South East of Misratah	1529	Region Civil Companies	Chalk & Gypsum	1980's	Un-Known	Finished site restored to Horticulture uses (Dates and Vegetable farm)	The site's status is curentl active.

53- Al-Qaddahiyah Limestone and Clay Quarry	South East of Misratah	1531	Misratah Civil Engineering Companies	Limestone & Clay	1970's 20 ha's	Un-Known	Finished site restored to agriculture uses.	The top layer of the quarr about 6 m high of clay, th lower is thick layer of Limestone.
54- As-Sidadah Limestone Quarry	South of Misratah	1431	Iron & Steel Company & Libyan Cement Company	Limestone	1976	Un-Known	No restoration.	The site's production in connection with the suppl of Limestone for use as fl in the iron & steel comple in Misratah.
55- Al-Jufrah Limestone Quarry	Waddan area	1929	Libyan Cement Company	Limestone	1979 100 ha's	Un-Known	Finished site restored to horticulture uses (Dates Farm).	The site is belong to Al-Jufrah Cement Project.
56- Wadi ad Dakar Limestone Quarry	5 km South West of Zliten town	1432	Libyan Cement Company	Limestone	1980	Un-Known	Finished site restored to agriculture uses.	The site's status is current active, and belongs to Zli Cement Plant.

57- Wadi Majir Limestone Quarry	5.5 South East of Zliten	1432	Libyan Cement Company	Limestone	1978	Un-Known	Finished site restored to agriculture uses.	The site's status is current active, and belongs to Zlit Cement Plant.
58- Ras el Margheb Limestone & Clay Quarry	North of the Al Khums Cement Plant	1432	Libyan Cement Company	Limestone and Clay	1968	Un-Known	Finished site restored to agriculture uses, with high number of foresty plantations	The site's deposit now sta exhausted.
59- Ras el Manubia Limestone & Clay Quarry	5 km west of Al-khums	1432	Libyan Cement Company	Limestone and Clay	1969	Un-Known	Agriculture restoration.	The site's productions are belong to Al-Khums Cem Plant.
60- Al-Juma Clay & Limestone Quarry	5 km West of Al-Khums	1432	Libyan Cement Company	Limestone & Clay	1970	Un-Known	Finished site restored to agriculture & horticulture uses.	The deposit forming low-lying hills below the clay.

61- Ras el Kabir Clay & Limestone Quarry	West of Al-Khums	1432	Libyan Cement Company	Limestone & Clay	1970	Un-Known	Finished site restored to agriculture & horticulture uses, and reservoir for winter floods.	The site is located close tc the shore.
62- Hasnun Limestone Quarry	15 km South East of Al-Khums	1432	Libyan Cement Company	Limestone	1970's	Un-Known	No restoration.	The site's status is current irregular.
63- Hasan Clay Quarry	20 km south of Al-Khums	1432	Libyan Cement Company	Clay	1970's	Un-Known	No restoration.	The site's status is current dormant.
64- Souk el Khamis Limestone Quarry	15 km of Souk el Khamis Village	1332	Libyan Cement Company	Limestone	1977	Un-Known	Finished site restored to agriculture & horticulture uses (Citrus & Olive trees).	The quarry divided to fiv fields A. B. C. D and E.

65- Abu-Ghaylan Clay Quarry	3 km North East of Abu-Ghaylan village	1232	Libyan Cement Company	Green & Red Clay	1977	Un-Known	Finished site restored to agriculture & horticulture uses (Citrus & Olive trees).	The site's clay is varied to both green and red clays were found.
66- Wadi Ghan Clay Quarry	7.5 km East of Abu-Ghaylan Village	1232	Libyan Cement Company & the local traditional pottery makers.	Green & Red Clay	1977	Un-Known	Agriculture & horticulture restoration.	The site's status is current active for both cement & pottery manufacture.
67- Bani-Walid Gypsum Quarry	2 km of Bani-Walid town	1331	Libyan Building Enterprises	Gypsum	1970's	Un-Known	No restoration.	The site's status is current active.

68- Libdah Anceint Limestone Quarry	0.5 km of the Anceint city well known as Leptis Magna.	1432	Libyan Heritage Institute	Limestone	Un-Known	Un-Known	Left to re-colonise naturally.	The Libyan Heritage Organisation plan is to op the site for scientific stud
69- Azzaweyah Building stone Quarries (7 sites)	North of the City	1232	Private Investment	Limestone	1959	Un-Known	The sites are located close to the shore, some of them are opened to allow the sea water enter to make a protected swiming area.	Most of the sites are currently active.

70- Sabratah Anceint Quarry	South of the Modern City of Sabratah	1232	Libyan Heritage Organisat-ion	Limestone	Un-Known	Un-known	The site was re-opened by the local people in early 1970's, but the Government prevented them to damage the archaeological ruins.	The UN organisation had recorded this location as a Global Heritage Site.

Appendix No 4. **Generalised stratigraphic succession in various regions of Libya**

(Generalised stratigraphic succession in various regions of Libya)

Period	North-western	North-central	North-eastern	South-western	South-eastern
Quaternary	*Holocene* - Recent wadi deposits, beach sand and coastal dunes, alluvial sediments, fluvio-eolian deposits, sabkhahs, sarir gravels, caliche crust and conglomerates. *Pleistocene* - Calcarenite with occasional silt and sand.			Sand seas of Ubari, Murzug and Rabyanah, sarir gravels. Late Tertiary to Quaternary volcanic rocks.	
Tertiary	Al Khums Mazul Ninah Wadi Tamet Al Jir Beshimah Surfa	Marada Bu Hashish Umm ad Dahey Wadi Tamet Al Jir Beshimah Surfa	Ar Rajmah Al Jaghbub Qaret Mariam / Msus Al Faidiyah Al Abraq Al Bayda Darnah Appollonia Al Awayliah		
U. Cretaceous-Tertiary	Zmam				
U. Cretaceous	Mizdah Qasr-Tigrinnah Nalut Sidi as Sid		Wadi Dukhan Al Majaheer Al Baniah Qasr al Abid	Murzuk	
L. Cretaceous	Kiklah			Messak	Sarir
Jurassic	Takbal				Nubian
Jurassic-Triassic	Bir al Ghanam				
Triassic	Abu Ghaylan Abu Shaybah Al Aziziyah Kurrush			Tassilien	
Carboniferous				Tiguentourine Dembaba Assedjefar Mrar	Thalma
Devonian				Wadi ash-Shati Awaynat-Wanin Ouan Kasa Tadrart	Binem Tadrart
Silurian				Akakus Tanezzuft	Akakus Tanezzuft

Period	North-western	North-central	North-eastern	South-western	South-eastern
Ordovician				Ayadhar Memouniat Melez-Chgrane Haouaz	Memo-niat
Cambrian				Hasawnah	Hasawnah
Precambrian				BASEMENT	ROCKS

After INDUSTRIAL RESEARCH CENTRE 1983.

Appendix No. 5

Samples of Letters sent to the planning organisations in UK

Letter 1

Printed by: **Salah ELBAH(LFM)** 31 August 2001

Title: **Environmental information** Pag

08 June 2000 17:32:57

Message

From:	Salah ELBAH(LFM)
Subject:	Environmental information
To:	mail@sifamaldn.org

Dear Sir Madam

My name is Mr. Salah M. Elbah, I am a Libyan student in England , going to do Phd i "An Evaluation of the Environmental Impact of Quarrying Industry, with special refere to case-studies in North Africa (LIBYA, MOROCCO) and in the UK, and to the potent EIA for recreation and conservation after-use." so in order to achieve a good result fo this studies, could you please provide an information, from your environmental organisations, of former quarries (Phosphate, Limestone, Sandstone, Chalk,...etc) w have been:

1- Left to recolonise naturally.
2- Converted to Natural Historic Sites.
3- Reclaimed for commercial use.
4- Reclaimed for amenity use.

Even more, information about Environmental Impact Assessment EIA in Morocco is required, and any Environmental procedures related to this subject.
This information, for Kingdom of Morocco, is required for a research project on the reclamation of the Environment of the former quarries and Landscape design, for recreation and conservation.

Thanking you in anticipation

Re. Salah M. Elbah
School of Leisure and Food Management
Sheffield Hallam University
City Campus

Letter 2

31 May 2000 14:01:13

Message

From: Salah ELBAH(LFM)

Subject: Derelict Land Register

To: minerals@bgs.ac.uk

Dear Sir Madam

Can you please provide a list, from your Derelict Land Register, of former Limestone quarries which have been :-

1- Left to recolonise naturally.
2- Converted to Natural History Sites.
3- Reclaimed for amenity use.
4- Reclaimed for commercial use.

This information,for former British Limestone quarries, is required for a research project on the reclamation of Limestone quarries.

Thanking you in anticipation.

Co. Dr. Frank Spode
Re. Salah Elbah
School of Leisure and Food Management
Sheffield Hallam University
City Campus
Sheffield S1 1WB
Email f.spode@shu.ac.uk

Letter 3

30 October 2000 18:50:23

Message

From: Salah ELBAH(LFM)

Subject: Environmental Information

To: p&t@leics.gov.uk

Dear Manager

Could you please provide a list, from your Limestone, Chalk, and Hard Rock Quarries, which have been:-

1- The site status is active.
2- The site status is dormant.
3- Left to recolonise naturally.
4- Converted to Natural History Site.
5- Reclaimed for amenity use.
6- Reclaimed for commercial use.

and could you please provide the:

1- Site Name.
2- Ownership.
3- Product.
4- Dates Worked.
5- Date of Closure.

This information, for Leicestershire County, is required for a research project on the reclamation of Limestone, Chalk, and Hard Rock Quarries.

Thanking you in anticipation.

Co. Dr. Frank Spode
Re. Salah Elbah
School of Leisure and Food Management
Sheffield Hallam University
City Campus
Sheffield S1 1WB UK